NATIONAL PETROLEUM NEWS

December 5, 1945

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DETROIT

TECHNOLOGY DEPT:

Guam 'Supermarket' Kept Black Oil Flowing for Navy Ships

Oil storage facilities at the Naval Supply Depot on Guam (shown above in aerial view) could take the entire petroleum production of the state of Oklahoma for five days. The depot, known as the "Pacific Supermarket," had more than 200 huge storage tanks with a total capacity of more than 1,000,000 bbls. for gasoline, fuel oil and Diesel oil. The scope of the depot's oil activities was described by Navy as follows:

"From the time it fueled the first ship on Christmas Day, 1944, until July 1, 1945, the Fuel Supply Branch of Guam Supply Depot, which handled petroleum products for both the Army and Navy, had issued a total of 231,167,000 gallons of fuel oil, 101,374,000 gallons of aviation gasoline and 85,932,000 gallons of Diesel fuel."

View here shows man-made causeway where tankers discharged oil which was pumped into the black oil tank farm in the hills

NPN Presents Complete Coverage of Senate Petroleum Testimony

Testimony now being presented before the Special Senate Committee Investigating Petroleum Resources represents a collection of some of the most complete data on the American oil industry ever gathered at one source. Compiled by leaders of the industry and top government agency men (such as Deputy PAW Davis in the current issue), the material is a documentary account of the history of oil in this country and the huge strides of advancement the industry has made. With four full-time writers on the job in its Washington bureau, NPN gives full coverage for its readers as the pages of oil reports are unfolded in the Senate hearing chambers.

It's Always Fair Weather to Tokheim Pumps

There is a Tokheim pump for every need—Computing and Non-computing models in Standard, Hose Reel and Stationliter types. (Model 39 Computer with Hose Reel illustrated.)

Whatever the weather it's always fair to Tokheim 4-Season Pumps. You'll find them in service from Nome to New Haven in all kinds of weather and terrain, delivering fuel to hungry motors quietly, accurately, safely. These famous Tokheims are now being built in steadily increasing quantities. To assure earliest delivery of yours, order now from your Tokheim representative, or write direct to factory.

QUALITY TOKHEIM
THE 4-SEASON PUMP

TOKHEIM OIL TANK AND PUMP CO.
Designers and Builders of Superior Equipment
FORT WAYNE 1 For 44 Years INDIANA

Over and over again the Ethyl emblem on your pumps tells customers that here is the quality gasoline they are looking for. It's on the job for you every minute that your stations are open . . . every time a pair of eyes look at your premium pump.

They're looking for the Ethyl trademark on your pumps

He Heads South Dakota Independent Oil Men's Assn.

Fred E. Frankell . . .

Fred E. Fankell, newly elected president of South Dakota Independent Oil Men's Assn., comes from the western part of the state "where men have big ideas," according to his many friends.

He has been manager and stockholder of Puritan Oil Co. at Rapid City in the Dakota Black Hills tourist country since 1937, and gets a tremendous kick out of doing it. Plenty of "gas", some new automobiles by next summer and elimination of "Don't Travel" restrictions add materially to the glow Mr. Fankell sees on the picturesque hill country horizon.

Mr. Fankell's popularity is attested to by his selection to serve on numerous industry committees. He was a member of the Dist. 2 Distribution and Marketing Committee; South Dakota Petroleum Industries Committee; ODT Committee on Trucks, and was recently named a councillor, U. S. Chamber of Commerce, in which capacity he represents South Dakota Independent Oil Men's Assn. He is also a member of the Masonic Lodge and last year served as deputy district governor of the Lion's Club. He is vice president of the Rapid City Lion's Club now and is due for election to the presidency next June. He has been a member of South Dakota Independent Oil Men's Assn. for eight years and has never missed an annual meeting. He belongs to the Trinity Lutheran Church.

He was born in a sod or "dobe" house in Tribune, Kan., near the Colorado line on June 9, 1893. There were four sisters and one brother. He took grade and high school in stride at Iola, Kan., and Longmont, Colo., graduating in 1911; finished a bookkeeping course at Greeley, Colo., in 1915, and spent a year at Valparaiso University in Indiana.

His first job was keeping books in a furniture store in Greeley. Later it was the tire business with his brother in 1919 at Longmont, where they purchased the first service station ever erected there. Since then it has been the oil business. He worked four years for Direct Service Oil Co., Minneapolis, Minn., before the move to Rapid City in 1937.

But it was at Longmont that he met and married Inga Sockness, a high school teacher from Wisconsin. They have a daughter, Ruth, who recently was graduated from Boulder (Colo.) University. Son Fred, Jr., 17, is a student at the School of Mines in Rapid City. He's studying engineering.

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BULLETIN

OK's ALASKA DRILLING SHIFT

WASHINGTON—The House Naval Affairs Committee Dec. 4 approved a switch of the Navy's exploration program in Alaska to a civilian contract basis and recommended to the Sheppard subcommittee of the House Appropriations Committee that the entire program be completed. Chairman Carl Vinson (D.-Ga.) said the program was "necessary for the defense of the country."

Although the switch to a civilian contract basis will increase the cost from an estimated $6,000,000 to an estimated $10,000,000, the Navy Department spokesmen said they were "forced" to let private contractors do the work because needed technicians would not remain in service or could not be recruited at existing Navy pay rates.

Commodore W. G. Greenman, director of Naval Petroleum Reserves said he favored having Navy complete the work, since discipline and administration would be in Navy's hands completely, but that this is impossible.

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NATIONAL PETROLEUM NEWS
NPN
NEWSMAGAZINE FOR OIL MANAGEMENT MEN

Companies to State Positions on Wage Dispute at Panel Meeting on Dec. 17

Management Will Not Be Asked to Discuss Past Profits at Hearing; May Present Cases on Plant-by-Plant Basis

NPN News Bureau

WASHINGTON—Investigation of the oil wage dispute by Labor Secretary Schwellenbach's fact-finding panel will begin Dec. 17 when companies will file briefs stating their positions on the wage question, it was decided at the panel's preliminary session with management and union representatives here Tuesday.

It was agreed that the companies and union may submit their cases in any form they wish. Companies will not be asked by the panel to discuss past profits during the hearings, which will be public.

Under the plan set up here Tuesday, the Oil Workers International Union will state its case first at the Dec. 17 session, then the companies will state theirs. Each will be permitted cross-examination. Panel members made it clear that the companies may express their viewpoints on a plant-by-plant basis if they wish.

Secretary Schwellenbach's orginal call set the date for the panel to make its recommendations on Dec. 27, 30 days after the date of his order creating the panel. This period was extended two weeks, with the proviso that all information must be in on Dec. 29. The report to Schwellenbach will be due Jan. 10.

It was reported that the O.W.I.U. talked during the session in terms of an increase of 38 cents per hour instead of 30%.

Fact-finders sat behind closed doors with representatives of 17 companies and two C.I.O. men throughout the first day's sessions, and a spokesman for the absent Oil Workers International Union President O. A. Knight had "no statement," but accounts of others indicated:

1. Lines were being drawn approximately as they were in discussions with conciliators which were shut off in October by Secretary Schwellenbach.

2. The union believes the wage question should not be considered in relation to cost of living, present wages or any other factor than profits which companies have realized.

3. Companies have no intention of baring books for public scrutiny, but are willing to discuss wages, cost of living and other such factual information with the panel independently of other participants in the inquiry.

Texas Statement Typical

Typical of this position was the statement by The Texas Co., which said, "We do not believe the company's financial condition or its profits in particular years are proper yardsticks for determining a wage question," adding . . .

"Because the company is convinced of the impracticability of industry or company-wide discussions, we will discuss with the panel the company's particular situation with respect to each locality, but only in closed session, independent of other companies and of the union . . ."

Other points made by the company included:

"It is our desire to be co-operative in the situation which resulted from government seizure of certain of our plants and in violation of law"; the company "assumes" members of the panel and the Labor Secretary accord with their view that there is no authority in law for the order creating the panel or for the investigation.

At the same time, The Texas Co. reported negotiations it has been conducting have been successful with all unions —24—representing its employes except C.I.O. units, that 17 A.F.L. affiliates and other unions have accepted the company's offer to increase basic wage rates 15%, and it is its "considered judgment" that it could settle all its remaining differences shortly if Navy control of seized plants were lifted.

Five companies had declined invitations to the inquiry. None, however, registered any objection to its character, according to Philip S. Brayton, executive assistant to the panel; one of them, Gulf Refining Co., Pittsburgh, Pa., explained it was engaged in negotiations with union.

Besides Gulf, they were American Liberty Oil Co., Dallas, Tex.; Elk Refining Co., Charleston, W. Va.; Humble Oil & Refining Co., Houston, Tex., and Phillips Petroleum Co., Bartlesville, Okla.

No response to invitations had been received, as the panel convened, from two others—Chalmette Petroleum Corp., New Orleans, and Petroleum Specialties Co., Flat Rock, Mich.

Companies participating and their representatives are:

Ashland Oil & Refining Co., Ashland, Ky.—J. Howard Marshall, president.

Atlantic Refining Co., Philadelphia, Pa.—P. G. Wharton, vice president; David Shar, assistant plant manager, H. Barton, attorney.

Cities Service Co. (Pennsylvania) New York—George H. Shaw and D. P. Sturges.

Cities Service Co. (Del.) New York—Charles M. Reed and Mrs. F. M. Butler.

Crown Central Petrol Corp., Baltimore, Md.—Karl F. Steinmann, general counsel, and John S. McDaniel, attorney.

Magnolia Petroleum Co.—W. H. Zabriskie and R. H. Lowe.

National Refining Co., Cleveland—Frank C. Heath, counsel.

Pan American Pipe Line Co., Houston—Rodney M. Nash.

Pan American Refining Corp., New York—Mr. Nash.

Pure Oil Co., Chicago—J. W. Rees and Ben A. Harper.

Republic Oil Refining Co., Pittsburgh—W. E. Houston and Norman L. Myers.

Shell Oil Co.—E. H. Walker and J. C. Quilty.

Sinclair Refining Co., New York—W. E. Brown, B. I. Stilphen and D. T. Pierce.

Socony-Vacuum Oil Co., New York—Mr. Zabriskie and Mr. Lowe.

Standard Oil Co. (Ohio)—W. A. McAfee, R. S. Stewart and C. H. Metz.

The Texas Co., New York—M. Halpern and James Tanham, vice presidents, and A. E. Van Dusen, attorney.

Union Oil Co. of Calif., Los Angeles —Gregory Harrison.

Military to Let Industry Prepare For War Oil Needs

NPN News Bureau

WASHINGTON — If a joint military-industry board to assure continued adequate oil supply for the Armed Forces is set up, the military intends merely to advise the industry of its requirements and let the industry work out its own methods with such help from the Army and Navy as it desires.

Commodore W. G. Greenman, who presented the idea of a joint board to the Senate Petroleum Resources Committee last week emphasized the only interest of the Army and Navy was to see that enough sustained productive capacity was available in event of another war. He estimated this capacity at not less than 5,000,000,000 bbls. per year for five years.

How this productive capacity would be achieved, Commodore Greenman said, would be left to the industry, along with responsibility for meeting specific military requirements in peacetime. Army and Navy would advise and help where asked, but the industry would be free to operate in any fashion which met military needs.

"Our only interest is in getting the oil we need, or having it available," the Navy officer said. "How the industry does it is none of our concern, though we will be glad to help them whenever we can."

(Earlier Story on Page 14)

Sen. Moore Cites Responsibilities of Labor and Management in Letter to O.W.I.U. Local Official

NPN News Bureau

WASHINGTON—Acting upon the receipt of numerous letters and cards from members of the Oil Workers International Union, requesting that oil plants be returned to their owners, Sen. Edward H. Moore (R-Okla.), a former independent oil producer, sent a lengthy letter to J. D. Ingram, secretary-treasurer of Local No. 217, Oil Workers International Union (C.I.O.), in Tulsa.

Excerpts from Sen. Moore's letter follow:

". . . . Numerous letters and cards from members of the Oil Workers International Union have been received and uniformly they request the plants be returned to their owners and that some governmental machinery be established by executive order designed to settle labor-management disputes. I, therefore, assume there is an organized campaign of the Oil Workers Union to seek assistance of the Congress in this connection.

"On this assumption, I am answering the letters and cards received by mailing to the senders a copy of this letter. The correspondence I have received raises the fundamental issue of the proper place of government in the field of labor-management relations. I am in hearty accord with the view that the seizure (of oil plants) was improper, illegal, constitutes a grave error on behalf of the President, and violates the constitutional freedom of both the employes and the employer to settle their controversies by peaceable and lawful methods. It is indeed encouraging to know that the employes of the seized plants who, as well as management, are victims of this seizure, are exercising the freedom guaranteed to them by the Constitution to protest such unlawful action.

". . . . Certainly petroleum was a war necessity, but the war has ended and we are now looking at the problem of reconversion and readjustment to a peacetime economy. Now that the war has ended the seizure of the refineries at this time is as unlawful and arbitrary as was the seizure of the Montgomery Ward retail stores which were never engaged in manufacturing any war equipment. It was as incumbent upon the members of your union and others to resist the Montgomery Ward seizure as it is now to resist the seizure of the oil plants. Had you and others of the country resisted at that time, it is probable that you would not now be in the position in which you find yourselves.

Cites Wage Increases

". . . . Following V-J Day, most of the refineries raised or offered to raise wages another 15%, thus making a total increase of about 36% in the basic wage scale within three and a half years. This is not a bad wage record. The war has been over four months and we have not yet started reconversion. Production of consumer goods throughout the nation is at a standstill as the result of two factors —first, the action of organized labor in bringing about work stoppages through strikes; and second, the action of OPA in maintaining price levels that make it impossible for thousands of manufacturing concerns to commence peacetime production. As a result of this shortage of production, prices are being bid up and the cost of living is rising day by day.

"If the President would face facts and release price controls so that incentive prices might prevail and organized labor would return to work, the result would be great production of consumer goods and almost overnight competitive prices would prevail, the cost of living would decline, profits would accrue to industry, and wages would be increased.

"If organized labor had understood this simple economic formula and had demanded of the administration that wartime controls be removed so that the nation could have quickly reverted to the peacetime production of consumer goods, then labor would have been in an economically sound position to have demanded and received a fair share of their productive efforts in the form of increased wages. The demands that are generally being made at the present time, however, are economically premature.

Must Have Production First

"The theory that industry can or should pay wages and operating expenses out of a surplus is an economic fable. No business can remain economically sound that cannot pay wages and operating expenses out of current production. . . . We must first have production before we can have reduced cost of living or high employment or high wages.

"A continuation of price control by executive order emanates from the same principle and theory that motivated the President to seize the refineries at this time. One is as illegal and economically unsound as the other and it is your duty, as well as mine, to resist one as strongly as the other.

". . . . It has long been recognized as wrong and adverse to the public interest for management to exercise its economic power to exploit labor by maintaining dangerous or unhealthy working conditions, unduly long workdays or creating conditions to oppress wages, and such should be prohibited by law. It is wrong for labor to seize and destroy the property of its employer, to resort to violence to enter into conspiracies to boycott or destroy business, and such should be prohibited by law.

"It is wrong for corporations, labor unions, or any other organization, to use their concerted influence and money to displace the proper functions of government or to control the duly constituted authorities by intimidation and coercion, and such should be prohibited by law.

"It is wrong for management or labor unions to force men to join or belong to a labor organization as a condition to his right to work and earn a living, and such should be prohibited by law. It is wrong for management at the dictates of union officials to deduct union fees and assessments from the wages of employes unless the employe shall agree, and such should be prohibited by law.

"It is wrong for unions to break their contracts and not be held accountable under the law as other citizens and corporations. It is wrong for union officials to assume dictatorial powers, make assessments and spend money at will to advance their own personal and political fortunes, and such should be prohibited by law. It is wrong for a national union to become the master of its locals; thus, it is essential for the local unions to maintain their own collective bargaining rights.

"You and other members of your union have raised certain fundamental issues that will determine our economic future. We must meet the issues fairly, squarely and without prejudice to our own personal positions. Unless we are willing to do that, constitutional freedom for both labor and management will perish.

Chicago Retailers And Truck Drivers Sign New Contract

NPN News Bureau

CHICAGO—New contract has been signed by Chicago Gasoline Retailers and Local 705 of Truck Drivers and Chauffeurs Union (A. F. of L.) to become effective Feb. 1, 1946, when present contract expires, according to Bradley Provis, president of Chicago Metropolitan Gasoline Dealers Assn.

Changes from old contract include provision for one week's vacation with pay after one year's service for each year up to five, with two weeks' thereafter, and an increase in the wage scale of 50% as compared with prewar rates. New scale does not represent 50% increase over wartime wages, however, because old contract was made in 1942 and wages were raised after that time. According to new scale a washer receives $32.76 (48 hour week) or 68.25c per hour, lubrication man and driveway salesman $45 or 93.75c per hour, female driveway salesman $41.76 or 87c per hour, lubrication man $38.88 or 81c per hour, and station manager $56.16 or $1.17 per hour.

Service Station Shut Down When 10 Workers Won't Join Union

NPN News Bureau

CHICAGO—Gasoline tanks at Stephen Shimeneck service station, Wilmette, are empty because the 10 men working there, seven of whom are World War II veterans, refuse to join the union, Forrest Glaves, manager for the past 9 years told NPN.

The business agent of local 705 of the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers Union (A.F.L.) demanded that he and his employes join and they refused, Mr. Glaves said.

Socony-Vacuum Union Rejects 40-Hour Week With 15% Wage Raise

Special to NPN

HAMMOND, Ind. — International Oil Workers' Union employes at Socony-Vacuum's East Chicago refinery voted Nov. 30 to reject the agreement providing a reduction to a 40-hour week with 15% increase in wages, effective Dec. 9.

Elwood E. Phelps, president of Local 210, O. W. I. U., said the vote was unanimous. If the vote had been favorable the agreement still would have been subject to any adjustment after the meeting of the fact-finding panel in Washington next week.

"The proposition looked too much like it might jeopardize something else," Mr. Phelps said, adding "urgency of decision was really unnecessary as the change in hours and wages would not become effective until Dec. 9 anyway."

Asked if O. A. Knight, president of O. W. I. U., Fort Worth, had approved the proposed agreement, Phelps said "no comment."

In Constant Contact

"Of course I've been in constant contact with Mr. Knight," he added.

"We are ready to lay our case before the fact-finding panel," he continued, "and are also ready for further negotiations with the company, but I do not know yet how the company feels. They may not want to do anything for a few days."

Bryan Reid, general manager for Socony-Vacuum in Midwest, told NPN that all he had heard was that the proposition had been turned down. From other sources it was learned that the seven-member Local 210 plant committee had approved the proposal "and agreed to take it back and attempt to sell it to the membership."

The opinion was that Mr. Knight had turned thumbs down. Main reason appears to be the company's refusal to make a full guarantee of acceptance of whatever decision the fact-finding panel arrived at. Local 210 demanded such a guarantee.

Mr. Phelps supplied the following details concerning the Nov. 30 meeting:

The call was issued about 3 p. m. Nov. 30 for the meeting at 7:30 p. m. The session was continuous for one hour and 15 minutes and closed to all but company employes. No international representative of O. W. I. U. or men from other plants were admitted, "because," Mr. Phelps said, "we didn't want anybody telling us what to do and wanted our men to speak up."

Between 280 and 300 Socony-Vacuum employes are members of Local 210, and a "little less than half" of that number attended the meeting, Mr. Phelps said. "But," he added, "since they voted unanimously against the proposal, we can consider it unanimous for all employes." It was impossible for all employes to attend the meeting without shutting the plant down, and under urging of company management for a quick decision, advance notice of the meeting was very short and some members who live at a distance were unable to make it.

The union was informed in advance by the company that rejection of agreement, which would enable a cutback to 40 hours weekly, would mean laying off 40 men Dec. 1 who are surplus under the 48-hour week.

Knight Says Socony-Vacuum and Union are Still "Far Apart"

Special to NPN

FORT WORTH, Tex.—O. A. Knight, president of Oil Workers International Union said Local 210 and Socony-Vacuum Oil Co. are "as far apart as ever" following rejection by the local's membership of a proposed settlement of wage differences at East Chicago, Ind., plant.

The local's negotiating committee, Mr. Knight said, "was not sold" on the proposal which it submitted to the membership.

Denies 30% Increase Was Given

CLEVELAND — The claims of O. A. Knight, president of the Oil Workers International Union, that the Canton Refining division of the Central Pipe Line Co. of Canton, O., agreed to a 30% increase in wages at its plant was refuted today by W. W. Vandeveer, president of Allied Oil Co., of which Central Pipe Line is a subsidiary.

Sketches of Members of Oil Wage Dispute Fact-Finding Panel

NPN News Bureau

WASHINGTON — Following are thumb-nail sketches of each of the three members of the fact-finding panel created last week by Labor Secretary Schwellenbach to study the oil wage dispute.

Mr. Graham

Dr. Frank P. Graham, chairman: ex-marine; president University of North Carolina since 1930; served as vice chairman of National Consumers Advisory Board and chairman of National Advisory Council on Social Security; public member of National War Labor Board; chairman of public hearings committee of National Labor-Management Conference. Sincere and honest, but regarded as a professional do-gooder and up-lifter whose main concern is for the "underdog." Author of NWLB's famous opinion in Humble Oil & Refining case which outlined the board's philosophy in support of maintenance of union membership in wartime. The vote in this case was 8 to 4, with all industry members concurring in a dissenting opinion written by James Tanham, vice president of The Texas Co., which called Dr. Graham's majority opinion "a flood of idealistic declamations but a dearth of demonstration."

Author also of the board's far-reaching opinion in Southport Petroleum Co. case holding that wage classifications based solely on race differences were without validity and ordering abolition of pay differentials between white and Negro workers performing equal work.

Mr. Beyer

Otto Sternoff Beyer: consulting engineer specializing in labor matters; director of section on labor relations, federal coordinator of transportation, 1933-35; member National Mediation Board from January, 1936, until becoming director of transport personnel for Office of Defense Transportation; now engaged as consultant for U. S. Maritime Commission. Brought considerable attention to himself last May by suggesting adoption of a code of fair practices for labor and management and advocating as a last exceptional resort, the "emergency procedure" of a factfinding panel "to prevent, if possible, strikes of especially grave consequence."

Mr. Eliel

Paul Eliel: director of divison of industrial relations, Stanford University Graduate School of Business, Palo Alto, Calif. Widely known to management and labor on West Coast, particularly in maritime circles. Chairman of War Shipping Administration's Pacific Coast Maritime Industry Board, and special representative and chief hearing officer for NWLB at San Francisco. In 1933-34 was special advisor on code matters and acting deputy administrator on Pacific Coast Codes for NRA.

Until recently, a member of U. S. Employment Service Advisory Council. Least known in Washington of the three panel members, but may turn out to be the most conservative in attitude. The few business men here with whom he came in contact before the war regarded him then as a "substantial citizen," and are hopeful of finding him still so.

Washington—By Herbert Yocom

Baruch Is Force Behind Bill Proposing Natural Resources Policy

WASHINGTON — Bernard Baruch, the esteemed elder-statesman, is the force behind legislation just introduced in the Senate proposing a national natural resources policy for the U. S. and providing the necessary implementing machinery in the form of a Natural Resources Council.

Mr. Yocom

Because of that fact, the measure (S. 1634) is commended for early study by every oil man, for the chances are that it will command far more than the usual attention from a Congress which already has demonstrated more than just casual interest in the matter of protecting and improving our resources position.

Senate sponsor of the proposal is able Sen. Pat McCarran, of Nevada, but the idea really originated with Mr. Baruch's testimony before a Senate Military Affairs Sub-committee late in October during which he urged, as a prime requisite to national strength and security, the need for a complete inventory of all natural resources, including oil, and the taking of steps that would insure adequate supplies for the future. The suggestion so appealed to Sen. McCarran that he and Mr. Baruch got together, and the present bill, drafted after numerous consultations with Mr. Baruch and with many different "mining men," including some in the oil industry, is the result.

Briefly, the legislation is grounded on the belief that future prosperity depends in large degree upon sound conservation and proper utilization of natural resources. It calls, among other things, for:

1. A national inventory of all natural resources, with an annual accounting to be made of both actual and annual depletion rates, together with a yearly estimate covering probable future production, utilization, and depletion rates over the ensuing ten-years.

2. Separate estimates, to be revised annually, of the probable national requirements for each and every critical or strategic material needed for war and essential civilian production during three years of war "under anticipated conditions."

3. Encouraging private enterprise "at all times" to discover and develop new sources of natural resources and to devise and develop new technologies for their production and utilization, with government to lend assistance "to the fullest extent possible within appropriations therefor made by the Congress."

4. The accumulation and maintenance of a natural resources stock pile adequate to meet requirements of a three-year war.

5. Banning of the sale, lease, loan or transfer to any foreign nation or foreign national for use outside the U. S. of any critical or strategic materials "of which there is a current or anticipated future shortage," except by presidential direction pursuant to a treaty obligation or in the interest of national defense or in the prosecution of a war.

6. Recognition of the cost of "unsuccessful or unproductive exploration" for new sources of materials as "a proper expenditure by the government in the interests of the national welfare," but with government to recapture the cost of successful explorations made, with the owners' consent, on private lands.

Responsibility for effectuating these policies would be lodged in a Natural Resources Council, composed of the Secretaries of Interior and Agriculture and three other members, each of the latter to serve for six years at an annual salary of $12,000. The council would be given a staff, be empowered to enlist the aid of other government agencies and offer assistance to the states on conservation matters, and to issue "such rules and regulations" as may be necessary to carry out terms of the act. In addition to keeping tab on domestic supplies, it would be required to report annually on the alternative foreign sources of supply of all resources.

Other provisions of the bill would authorize the Secretary of the Interior to spend up to $10,000,000 annually on a "continuing program of exploration and development," and a like sum on laboratory and demonstration tests of new utilization methods.

Sen. McCarran already has given notice to the Senate Committee on Public Lands and Surveys, to which the measure was referred, that he wants public hearings held at the earliest practicable date, probably soon after the first of the year. Likely witnesses at that time will include Secretaries Ickes (Interior) and Anderson (Agriculture), the bill having been "cleared" with officials of both departments, although pledges of support were neither sought nor given.

Atlantic Coast—By Frank P. S. Glassey

Fur May Fly if Panel Members Demand Access to Company Books

NEW YORK—Fur in large quantities may fly at some of the meetings of oil industry representatives and the fact-finding panel appointed to inquire into the wage dispute. This is particularly likely if panel members demand access to company books and detailed data on costs and profits.

Mr. Glassey

The composite industry attitude, as revealed in informal comments by a number of executives, is that this subject is none of the panel's or the public's business, and the government has no authority to demand such information. Thus there is a slight parallel with the General Motors-labor impasse, where the company has refused to open its books. In both cases the company attitude appears eminently justified, in law and common fairness.

There is still another parallel, however, and one not so pleasant. That lies in industry's failure to tell its story to the public as well as the unions have done.

It is generally agreed that U.A.W. has done a far better job in publicizing its arguments than has General Motors. A similar statement holds true in the case of oil industry right now.

Thus: (1) the major companies appreciate that the principal purpose of the fact-finding panel is to issue a report which will influence public opinion; (2) the panel is considered predominantly pro-labor in character, and hence its report is likely to bolster the union's side in the wage dispute, and yet (3) the major companies have made absolutely no plans for any campaign of their own designed to counteract what may prove extremely damaging propaganda. This laissez-faire attitude may be defended so far as the merits of the controversy are concerned, but it also may be a very costly form of inertia.

° ° °

Somebody in Philadelphia seems to be flirting with the anti-trust laws in seeking to organize service station operators and to secure establishment of resale prices on gasoline under the Pennsylvania fair trade law, "to guarantee the dealer margin of profit."

The organization drive is being conducted by Local 187 of the Teamsters Union, affiliated with the A. F. of L. It aims to enlist dealers who lease stations as well as those who own and operate their own stations. There are approxi-

mately 2000 such dealers in the Philadelphia area. Objectives include a six-day, 72-hour week and the elimination of the recapture clause from contracts.

It is on the price angle, however, that the union apparently is running into dangerous legal territory. James J. Stoltz, secretary-treasurer of the Teamsters Council in Philadelphia, has vigorously disclaimed any attempt to control prices.

"Let the dealers charge any price they care to," he said, "as long as a reasonable profit margin is maintained." The last clause carries the joker. If the dealers try to get together to determine what that "reasonable profit margin" is, it is a fair guess that the Department of Justice will step in to investigate illegal price fixing.

You can get odds in Philadelphia that the drive to organize dealers in that area will fare no better than did similar attempts in Minneapolis and Cleveland.

* * *

PAW Dist. 1 expired gracefully on Nov. 30, but the aura of oil will still hover over the two floors it occupied in the Chanin Building here. The Texas Co. has taken over 7000 square feet of floor space in the former PAW offices for its northern territory sales headquarters and Pan American Petroleum has leased 4500 square feet for its traffic department.

PIPELINES — NPN Writers at Three Vital Points Discuss the Industry's problems

Midwest—By Earl Lamm

F.O.B. Trend Seen Evident Among Marketers as Competition Tightens

WATERTOWN, S. D.—This department has been mulling over an idea advanced sometime ago by a major oil company division sales manager, which seemed far fetched, but which may come to pass.

Mr. Lamm

It was pointed out that manufacturers have long figured that 60% of the sale price of any article (exclusive of sales tax), represented the cost of selling it; that is, distribution cost. That leaves only 40% for manufacturing and profit. Since profit is limited by competition—the keener the competition, the less profit—the greatest possible saving is in distribution cost. If earnings are 6%, the remainder, 34%, represents production cost. If some genius managed to cut that cost in half it would be a reduction of 17%—a remarkable figure that almost never is accomplished quickly. But from a sales approach, a 50% reduction in cost would be 30% saving—nearly twice the 17%. It may be possible to go even further than that from the manufacturer's position.

In manufacturing, the hand touches concrete things—iron ore, pig iron, steel, nuts, bolts, bodies, upholstering. A salesman has only one concrete thing to lay his hand on (excepting the customer's money)—the product, a new automobile, for example. From there on he essentially follows an uncharted course. He deals in human nature, often a capricious thing. Psychologists claim they have analyzed it, broken it down mechanically, so that they can take it apart and put it together again like assembling a fine watch. But when one psychologist fails to sell his study course to an interested prospect, another with a slightly different approach or personality comes along and enrolls the prospect as a student. It disproves all arguments about their mechanized analysis of human nature being accurate and complete.

Many more people are employed in marketing than are engaged in manufacturing. Day-to-day selling is a bigger, more complicated problem than day-to-day manufacturing.

"If marketing becomes too much of a burden," speculated the major oil company sales manager, "manufacturers with well established products may get out from under it, or simplify it for themselves. Suppose for example, that Ford Motor Co., which has made some drastic moves in the past, should say when announcing a new model car, 'Here it is, F.O.B. Detroit. Come and get it!'"

There are many arguments why that cannot or will not be done, but a substantial reduction in the price of Ford cars would be possible. Financing dealers and customers, used car trade-ins or disposal, transportation difficulties and other distribution losses and headaches for the manufacturer would be eliminated. Dealers could determine their own delivered prices, make their own deals on service and used cars. Distribution would be the local dealer's problem.

As competition tightens and oil marketers are compelled to analyze their costs thoroughly to spot corners that can be cut, they evidence desire now to partly apply the "come and get it" idea to petroleum products distribution. Some jobbers who attended the South Dakota Assn. convention here last week, said that tank wagon peddling of products to farmers 20 miles out at prices cheaper than he can buy them in town should be stopped. The grocery wagon does not go that far, even at high over-the-counter prices. Tank wagon owners, the jobbers said, do not figure their cost sufficiently carefully, and often their farm business is done at a loss. It was argued that rural stations can give better service than a tank wagon—can grease and service a car or tractor better than a farmer can—or does.

Carrying the thought back to the refiner level, major companies have often claimed annual marketing department losses, and already have established prices to jobbers F.O.B. their plants. Thirty-two government agencies are now meddling with oil. Congress wants to eliminate cartels; Justice Department is on an anti-trust prowl. Should the 32 government agencies and anti-trust action create a future critical situation, refiners and other big manufacturers might proclaim a "come and get it, F.O.B. plant" policy. Top oil executives have frequently declared that they do not want another trip to Madison.

* * *

Competition in the farm market grows. Thousands of 300 and 400 gal. tanks on stilts and equipped with hose and nozzle for gravity flow are being supplied to farmers by oil companies. The tanks are replacing one or two drums per farmer in this area. Theoretically, 1c a gal. is added to product prices until the $70 or $80 cost of the tank equipment is paid out. What happens later will be anybody's business. Larger gallonage per purchase at cheaper prices is in prospect.

* * *

Another jobber opinion: If the FTC's Detroit order (Docket 4368) sticks, it will later be applied to the sale of motor oil. Quantity discounts are being given recklessly and in violation of the Robinson-Patman law. Salesmen solicit a dealer's oil business on, say, 8c a gal. off on a stated quantity purchase. The dealer can not accept delivery of that quantity at once, so the Q.D. is allowed in advance by applying it to the first small shipment. No written contract.

* * *

A very significant change is taking place in the strike situation. As the Christmas and New Year holidays approach, the holiday-with-money mood that has hovered about practically all strikes in all industries is disappearing. It is already gone from oil.

San Joaquin Producers Urge Gov. Warren Act on Tidelands

NPN News Bureau

SAN FRANCISCO—Directors of the San Joaquin Valley Oil Producers Assn. have adopted a resolution urging Gov. Earl Warren "to resist vigorously any attempt on the part of the federal government to gain title to the lands now belonging to the State of California."

Editor's Page

Truman Administration's Kangeroo Court Is Now Sitting on the Fate of Oil and All Industry

THE oil industry, all American industry and yes the American people, are before what may well be called a "court" at Washington this week. This "court" expects to make as momentous a decision as can be made these days, a decision on as important and complex a question as there well can be, a decision that can cost the American people billions, and may invite great trouble in our internal relationships, a decision which may well start this country on real inflation.

The decision of this "court" will be whether or not the oil industry should grant the 30% wage increase for a 40 hour week demanded by the CIO Oil Workers Union. Judging from all the maneuvering by the Truman administration it is fair to assume that this "court" is expected by its creators to approve that 30% increase or something as close to that as possible.

If the oil industry can be saddled with any such 30% decision, it can well be expected that it will be hailed by unions in all industry as a precedent for similar increases. If industry does not surrender to such a decision then most certainly can industry expect to be damned from the White House on down through all the labor union offices and homes of the radicals in the country.

So it is easy to see how vastly important the decision of this "court" will be.

What then is this "court"?

Labor Secretary Schwellenbach in "creating" it says he does so "pursuant to the authority vested in me as Secretary of Labor." Where in the Constitution or an Act of Congress is there provision for any such "court" that will decide such a momentous question for the American people? The members of this "court" are not to act as "conciliators" or "mediators" to "aid in the negotiations" between these employers and employes, to use only their friendly offices to try and bring about an agreement between the two parties. The members of this "court" are to go much further than that, they are to make a decision involving the rights of all citizens.

Just what is this "court's" function?

It "shall investigate the labor dispute relating to wages which should be paid on the resumption of a 40 hour week" in the oil industry and it is to report "its finding of fact and recommendations" which must not go beyond the hold-the-price policy of OPA.

How is this court to "investigate" and arrive at its "recommendations"? What is to be its procedure, its taking of "evidence", its weighing of the facts?

On procedure there are no instructions or restrictions. It is entirely up to this "court", save that the "court" is ordered to "give the parties to the dispute an opportunity to express their views on the procedure", and it further is ordered that "any party" can submit facts on a plant-by-plant or company basis. But after receiving these "views" and data, the "court" can do what it pleases even to ignoring them entirely.

In short this "court" has all of the attributes of an ill-famed "kangeroo court" which means that it has none of the precedents, restrictions, regulations and fundamental law of our established courts.

Who constitutes this "court" and exercises all of its unlimited and unspecified "authority"?

Labor Secretary Schwellenbach in announcing his "creation" of this "court" specifies its size and character by causing it to consist of "three members representing the public interest." He then names the three members without having consulted with Congress, which the public has chosen to represent "public interest", and without having consulted with the oil industry.

Who are these three "judges"?

All have been active in New Deal government and are recognized as more or less active disciples of its theories and policies. One in particular, the chairman of this body officially known as a "panel", has been in the New Deal since its start and has written at least one of the highly partisan and "New Dealish" decisions of the National War Labor Board. From the conduct of its three "judges" it would seem that this "court" is well stacked for the CIO which is another justification for calling it a "kangeroo court."

How searchingly can this "court" "investigate"?

It has no power of subpoena, no power to call witnesses, to swear them, to make them give testimony, not even the power to command "the truth, the whole truth and nothing but the truth."

It is well for the industry to understand the broad effect that this "court" can have on the industry and on the public because no matter how faulty the "investigation" may be, or how far from fact and common sense its findings may be—and the record of these individuals well justifies fear of that—if the decision favors the CIO, the Truman Administration almost certainly will at once undertake to give it national application, not only in oil but in all industry.

While the order of Schwellenbach "creating" this "court" might be construed to limit its investigation to the refineries that have been seized by the Truman administration, the immediate practical effect will be against all branches of the oil industry for the CIO Oil Workers Union is not limited in membership to refineries, but includes men in production, on pipelines, in oil field and transport trucking and others scattered in oil marketing. While the CIO is weak in these other divisions of the industry a 30% increase in wages in the refineries would be vigorously prosecuted by the CIO against employers in all other branches of the industry.

Perhaps this "court" will surprise everyone and "find" for the 15% increase which the companies have offered, but in view of the extreme CIO bias of the Truman Administration, in view of the vigor with which its representatives undertook

READERS' comments and opinions will be much appreciated by Warren C. Platt, NPN's Editor and Publisher, Penton Building, Cleveland 13, Ohio.

to bully the oil refiners into granting the full 30% during "conciliation" negotiations and later at Washington when Schwellenbach seemed to believe that all he had to do was to let the oil men hear his voice and they would capitulate to the CIO—it is almost a foregone conclusion that the "court" will "find" for the CIO and that such "finding" will be nearer 30% than the 15% offered unless Congress and the public have so impressed the administration with the unjustness of that as to scare even the CIO.

Truman Blind to Law Violations of CIO But Severely Condemns the AF of L

President Truman showed his extreme bias for the CIO the other week when he bawled out the AF of L union that operates the Washington street cars and buses, for violating its contract by striking. Truman seemed to think this was a terrible thing for the union to do, to violate a contract. But Truman has been absolutely silent on all the other violations of contracts, particularly by the CIO. Though the steel companies are protesting a strike vote taken by the NWLB as illegal because it would authorize a strike in violation of contracts, one hears no loud cries of anguish from the White House at this "official" contravention of the law.

Nor did any sound emerge from the White House when the CIO struck refineries in direct violation of contract, or picketed refineries and shut off their brother CIOers from working at other refineries even though the workers had signed contracts not to stop work or have strikes.

And needless to say, Labor Secretary Schwellenbach, the "creator" of this "kangeroo court" that is "trying" the fate of the oil industry and the public, also has been deeply silent about these and all other law violations of the CIO.

Hence it is hard to believe that this "fact finding panel" cooked up from within the inner recesses of the New Deal is going to follow any procedure contrary to that of its creator, the Truman administration.

And speaking of violations of law, has any one heard Truman or any member of his administration admonish, even a wee bit, the unions for using picket lines to stop lawful entrance and egress at the struck plants? Yet who can call the physical obstruction of plant entrances "peaceful picketing"? Or who can call the reviling of those who may desire to work and thus feel called upon to cross the picket line, "peaceful picketing"?

There was a time when the courts would undertake to protect a citizen in his right to proceed peacefully along a highway or lawfully enter property to try and earn his living. There also was a time when some public officials would enlarge the police forces or even call out the national guard to protect the rights of its law-abiding citizens.

But that was before the labor unions had so successfully bartered with, or bullied, those in the White House and Congress and other high places, and traded votes for power —power both within and without the law.

Profits Now to Be 'Shared' by CIO; Why Not Call Out the Stockholders?

The oil companies probably will be asked by the "kangeroo court" now sitting at Washington, and if not by the "court" then certainly by the CIO, to produce their operating books so that the union and the "court" can determined the amount of profit and the amount that "should" be paid them in wages.

This demand is being made of the automobile and also the steel companies, all of whom have refused on the ground that profits belong to the stockholders and that in disposing of them the best interest of the customers must also be considered.

It is high time that the owners of businesses in this country spoke up for the rights of those businesses and for the rights to the profits from those businesses. Profits have been so much reviled the last dozen years by the do-gooders, most of whom wanted a big slice of those profits and were sore because they had not been able to find a way to get them, that profits must be explained and defended. The people to do it are those who own them.

Many people in and about the oil industry have talked about an industry public relations campaign. At the last API meeting that organization voted $50,000 for a survey of public opinion of the oil industry. But long before that survey can be finished, a campaign devised and carried on and some years before that campaign can possibly have any effect on behalf of the oil industry, the oil companies, big and little, will have to fight still harder for their profits.

It would seem, therefore, that the men who have to do with public relations should act now on one idea. They should tell the story of the oil company stockholders, who they are, where they live and what do they do for a living. It could be shown to the rest of the public that these are every day citizens who are self-respecting, law-abiding and who are making some of the most worth-while contributions to our economy, as the professors like to call it.

However, to-date only one oil company, so far as we know, has ever told a real story about its stockholders, the Union Oil Co. of California, yet all oil companies, big and little, have a most interesting and truly American story to tell. Their stockholders, all of them, live right down the same street every one else does, go to the same lodge, church and school, buy and sell in each other's stores, have the same doctor who also is a stockholder.

What this oil industry should do, and all other industry also, is to educate its stockholders to an active and keen sense of proprietorship so that those stockholders will get up and fight for their businesses which is also the one you may be hired—just hired—to run. And this is something each company, both large and small, can best do for itself. Each can start doing it now, without waiting for the "other" to come into a common campaign.

If this is not done pretty quick, and maybe even now it is too late, the CIO and all the rest of the boys who are reaching for more power, will be "sharing" the profits with themselves without regard to the customer's interest, without regard to the government's interest as a tax receiver and most certainly with no regard whatsoever for the men and women who own the business.

Maybe the management of the oil industry will get such a scare during the "fact finding" of this "kangeroo court" at Washington in the next 30 days, that management men will call on the guy they are really working for, the stockholder, to come and help?

Truman's Strike Record Damns His Legislative Proposal

The foregoing, written before President Truman presented his strike settlement (?) plan to Congress, is a fair comment on that plan. All that has been said above points to the inherent weakness in the situation which is not so much the lack of a plan as the double-dealing of the Truman administration, and its very evident fear and refusal, to do the courageous thing and see that the unions obey all laws just as ordinary citizens must.

A fact-finding panel under a new law that is no better or less biased than the panel appointed to act in the oil strikes

appears to be will not avoid or end any strikes because neither unions nor management can have any confidence in their fairness. This oil strike panel may surprise us by fairness but, in view of its complexion, that is unlikely. Such a one-sided panel is but to be expected from the willing obedience of the Truman administration to the wishes of the unions, and the way its conciliators and mediators and even its labor secretary talked one way to the public and to the oil employers and then did everything they could to bully the refiners into granting the 30% demands of the CIO.

From the very start of the difficulty the Truman Administration's handling of the oil strikes has been either unbelievably stupid or downright dishonest and cowardly. If Truman and his associates do not change from those tactics with the U. S. Steel Corp. and General Motors, there can be no hope of industrial peace from anything he does.

However, Truman, by his very appeal to Congress for a vague and innocuous procedure, is in fact admitting his own failure and his need for help from Congress. This should be invitation enough for Congress to take hold of the situation which many of its members have indicated they are anxious to do, and enact such legislation as will make and keep labor unions amenable to the laws of the land and cause them to consider the rights of the owners of property and the rights of the public.

Industry Feels U. S. Interferes in Dispute

NPN News Bureau

CLEVELAND — Government meddling muddies the water.

That's the terse, conclusive way seven major oil company executives phrased last week their feeling about President Truman's union-management fact-finding committee.

Two of the oil industry leaders went further: They charged the panel with uselessness and suggested it would be better for the whole thing to be dropped.

One official came out flatly with this statement:

"Graham (head of the panel) has demonstrated his position—that industry can pay anything. He's very much a New Dealer. Beyer (another member of the panel) has been in and out of Washington on various government matters and is presumably very much on the New Deal side. I don't know Eliel (another commission member) so well, but he is about the same."

Candidly, the same official adds this pungent commentary:

"Am afraid these three fellows have been set up with instructions as to what they will find. Industry is not only fighting unfair union demands, but also government; and the background of these three men is just what we expected."

The oil company leader pulls no punches. Added to his forthright remarks are these words:

"We will go to Washington on Dec. 4 since we cannot refuse a government order, but we won't give them our books. Profit or lack of profit has nothing to do with it. Since Jan. 1, 1945, employes have had an increase of from 45% to 50% on an hourly basis and 60% on take-home pay basis; (in 1941 employes worked 36 hours weekly.)

"These are our figures, which approximately correspond to industry averages and include the 15% which several companies have offered and which, as I understand it, has not been withdrawn. So it would seem the boys have had pretty good recognition as the Labor Department cost of living figures show an increase of only 29%."

Another industry spokesman said:

"I don't think a true fact-finding group could justify a 15% increase (and) I don't see why one industry should be given much higher pay than workmen in other industries . . ."

A company division manager asserted:

"If they want us to come down (to Washington) and talk, all right—but I feel like General Motors does about opening our books."

General Motors attitude has been that union is not entitled to view its confidential earnings reports.

Said an oil company attorney:

"The first thing they (the union) demand are earnings and balance sheets . . . . So they can decide how much C. I. O. should get . . . I don't agree with that move."

An oil company superintendent added this gloomy note:

"I'm not very optimistic about the panel. The labor-management conference failed. Any wage increase is tied up with future profits and not past profits. . ."

300 Station Operators in Philly Area Join Union

Special to NPN

PHILADELPHIA—Almost 300 of the 2000 service station operators in the Philadelphia area have already enrolled with Local 187 of the Teamsters Union, affiliated with the American Federation of Labor, it was announced by the union this week, as it intensified its drive to organize gasoline dealers here.

James J. Stoltz, secretary-treasurer of the Teamsters Council, said 73 operators signed with the union at the initial organization meeting Nov. 15. At a second meeting a fortnight later, he said, approximately 100 additional operators signed and paid initiation fees, and since then a further 100 have been enlisted. Mr. Stoltz expressed himself as greatly encouraged at the local response to the drive, and predicted a majority of local lessee and individual station owners would soon join the union.

He defined the immediate objectives as follows:

1. To retain the 72-hour week of service station operators.

2. To secure establishment of resale prices on gasoline under the Pennsylvania Fair Trade Law, "to guarantee the dealer margin of profit."

3. To secure a working agreement with the majors "to prevent unfair competition among their own dealers."

4. To eliminate the recapture clause from contracts.

Mr. Stoltz denied that the union is seeking to control prices, and said dealer members will be free to sell at any price they choose, "as long as a fair margin of profit is maintained."

The unionization drive has been backed by the Associated Gasoline Retailers of Philadelphia and vicinity, according to its president, A. Reed Engel. Mr. Stoltz said that during the past week about 50 dealers have assisted union organizers in their campaign, and he predicted a large new enrollment at the meeting scheduled Dec. 6.

Truman Asks Fact-Finding Board Be Used in All Labor Disputes

NPN News Bureau

WASHINGTON — Setting up of permanent fact-finding machinery for the last-ditch settlement of labor disputes in major industries, including oil, was recommended to Congress this week by President Truman.

The President's proposal is for writing into the general law the same procedure now being followed in the oil wage dispute case and adds to the importance of that proceeding for the reason that its outcome will have an important bearing on any legislation introduced in Congress that embodies the White House Program.

As in the oil case, fact-finding boards suggested by Mr. Truman would have to rely on the pressure of public opinion to obtain acceptance of their recommendations by management and labor. But they would have one power that the Oil Wage Panel does not possess—the power to subpoena witnesses and company records.

"The parties (to a dispute)," the President said in a special message to Congress, "would not be legally bound to accept the findings of or follow the recommendations of the Fact-Finding Board, but the general public would know all the facts. The result, I am sure, would be that in most cases, both sides would accept the recommendations."

South Dakota Independents Adopt an Aggressive 6-Point Program at Record Watertown Meeting

By Earl Lamm
NPN Staff Writer

WATERTOWN, S. D.—A record attendance, five good speakers, an aggressive six-point program for the coming year, election of new officers, a delightful banquet followed by dancing, plus entertainment were the highlights of the annual convention of South Dakota Independent Oil Men's Assn. held here on Nov. 26-27.

In his report on association activities during the past year, J. E. Adrian, executive secretary, said that 32 new members were added, bringing the total membership to 318. In number, this is more than 90% of all jobbers in the state, and represents considerably more than 90% of jobber gallonage, indicating that leading jobbers belong. During the six years Mr. Adrian has been secretary, 275 new members joined, which brought the association out of the doldrums. Convention registrations totalled 272.

The speakers, in order of their program appearance, were: Warren C. Platt, publisher of NATIONAL PETROLEUM NEWS; Joseph E. Yonts, district manager of Firestone Tire & Rubber Co., Omaha; Capt. A. A. Nichoson, The Texas Co.; Leroy L. Snyder, past president of the Nebraska Assn.; and F. B. Caldwell, executive secretary, Distribution Division, Oil Heat Institute.

Retiring President Frank M. Hahn, in his opening remarks, emphasized the importance of unified effort through the association, which has a persuasive way of getting things done. The morning session was devoted to registrations and reports by association officers and committees.

Following a Dutch luncheon provided by the association at the City Auditorium where the meeting was held, Mr. Platt gave his address, "Oil Men in the European War Theatre."

Mr. Yonts declared the importance of his subject, "Service Station Merchandising," comes from the fact that stations in normal times have 1,500,000,000 selling opportunities a year as 30,000,000 people buy gasoline at least once a week. In coming to the station, he pointed out, the gasoline customer is forced to bring his automobile "wardrobe" with him, which gives the service man an opportunity to look it over and suggest repairs or additions. He showed that:

1. Free air for the tires is the key to recapping and new tire sales.
2. Free water for the radiator is the key to fan belt, anti-freeze, radiator hose, heaters, heater hose, radiator flush and seals sales.
3. Free windshield cleaning is the key to wiper equipment and defroster sales.
4. Free battery water is the key to battery recharges and new battery and battery cable sales.
5. Free spark plug testing is the key to new spark plug and ignition service sales.
6. Getting the car on the "lift" is the key to real inspection of tires, exhaust extensions and muffler sales.

Hints to Operators

Cautioning station operators about their sales psychology, Mr. Yonts asked "Do we tell the customer that his gasoline tank is half empty or half full?"

Other problems were hinted at in these questions:

1. Do we know how to correct a battery hydrometer reading for a change of, say 30 deg. in temperature?
2. Do we know how to use a spark plug heat range chart? How many stations even have a heat range chart?
3. Do we know that when using a battery high rate charger on a sulphated battery, the one thing to watch above all others is the temperature of the battery acid—if too high for a long period of time, the battery will be damaged?
4. Do we know that a No. 1 battery cable will carry two times as much current as a No. 4?
5. Do we know how to analyze a truck, figure pay-load distribution on the tires?
6. Do we recognize the importance of an air gauge?
7. Do we know how to repair and properly mount a synthetic tube? Certainly, repairing and application of synthetic tubes is very important.

Points like these, asserted Mr. Yonts, emphasize training and educational work that must be done if the service station is to be successful in merchandising. The discussion was then extended into ex-

Objectives for 1946 Are Set Up By S. Dakota Independents

By NPN Staff Writer

WATERTOWN, S. D.—In lieu of resolutions, the South Dakota Independent Oil Men's Assn. convention adopted these objectives for 1946:

1—That the board of directors act as a committee to work with other organizations such as the South Dakota Petroleum Industries Committee, the South Dakota Petroleum Transporters Assn., Associated Motor Carriers and others who are interested in a good road program properly financed; and that they be required to submit a report to the next convention which may be used as a guide for proposed legislation for the 1947 session.

2—To continue our efforts to secure simplification of the refund procedure for the federal 1½-cent tax on tractor fuels.

3—To continue our efforts against unnecessary regulatory laws, rules and regulations.

4—To continue our efforts for the repeal of the federal gasoline tax and the federal lubricating oil tax.

5—Suggest that dealers and jobbers in each city organize into local groups for the mutual protection against proposed unfair city ordinances and the possible adoption of a schedule of hours for service stations such as now are adopted by various Chambers of Commerce for the regulation of other retail establishments. To this effort we promise the services and initiative of our secretary to give all possible assistance in getting such groups organized.

6—That the board of directors act as a committee to confer with the director of licensing with reference to any proposed amendment to the refund section of the Motor Fuel Tax law which would require a state invoice system similar to that used by the State of Nebraska.

Members Gather for a Pre-Convention Chat

NPN Photo

Shown here just before the banquet at Masonic Hall are (left to right): Ralph Risser, Continental Oil, and A. V. M.Murray, Anchor Refining, both of Kansas City; B. D. (Doc) Dawson, Tansel Oil Co.; Forrest J. Ellsworth, Anderson-Prichard; and R. D. Hickman, Brown Steel Tank Co., all of Minneapolis

panded merchandise lines, the limits of which were not yet foreseen. To handle that and other problems, dealers need "mental reconversion" and must "get down out of the clouds before the shock of normal competition hits them." Clean stations and courteous customer treatment were designated as "must," and house-to-house calls, "very important."

During Monday afternoon between speeches by Mr. Platt and Mr. Yonts, a color movie, "South Dakota" produced by International Harvester was shown.

On the second day of the convention, Mr. Snyder and Mr. Caldwell were heard. Mr. Snyder, who spoke first, called himself "just an ordinary oil jobber," handling Mobil products in a four-county area of Nebraska with volume of nearly 5,000,000 gal. He also has an automobile, tractor and truck parts business. His convention address was in two parts. In the first, covering "association work," he pointed out that there are less than ten major companies in the United States and in South Dakota alone there are more than 300 independent jobbers.

"If we have troubles," he said, "either with the laws or any phase of business, as an individual, we are hopelessly lost. Collectively, however, we are a power in the petroleum business in South Dakota, Nebraska, Iowa and the United States. We are looked upon as giving more employment, handling more gallons of petroleum products and doing a greater service to the people of the United States than any other class of people in the petroleum business."

Cites Nebraska Assn.

In "getting things done," he cited accomplishments of the Nebraska Assn. with which he is more familiar. They included a change in inspection fees, affecting a saving of $40,000 annually. A new state law, allowing a small percentage for collecting gasoline taxes to cover oil company collection cost, added $50,000 more to savings. On a wider basis, getting together with National Council of Independent Petroleum Assns., he said, had proven effective, especially during rationing.

Part II of Mr. Snyder's address was devoted to pointing up the qualifications of a successful jobber. They were listed as (1) a financier, (2) credit man, (3) sales manager, (4) ability to handle personnel, and (5) extraordinary ambition.

Warning against too liberal credits and lack of adequate bookkeeping records to show costs that might not justify price reductions, Mr. Snyder said "I believe that the biggest trouble in the marketing of petroleum products, does not come from the large integrated companies, with reference to price cutting, but through the so-called independent who does not know what it costs him to market a gallon of petroleum products."

In his address on "Fuel Oil Sales and Service" Mr. Caldwell noted the expanding market for both oil and burners. He urged that consideration be given trade practices which will benefit both the industry and customers. Some past practices in "buck passing" on service, he said, have not reflected credit upon the oil industry and are some reasons for the increasing number of fuel oil distributors going into the oil burner business and why many burner dealers are likely to engage directly in the oil business.

Co-Op Members of S. Dakota Assn. Attend Convention

NPN Photo

Eighty-five co-op oil men are members of South Dakota Independent Oil Men's Assn. On the right is Roy S. Benthin, manager, Hamilin County Co-op Oil Co., Hayti, S. D. Next to him is Anton Bunde, president, same co-op. R. H. Hyde, Hyde Oil Co. and Mayor of Pipestone, Minn., leans on his elbow. Arthur Bell puffs a cigaret and Wiliam Janson, both of the co-op, look interested.

NPN Photo

Officers and directors of South Dakota Independent Oil Men's Assn. pictured here are (seated, L to R): J. E. Adrian, executive secretary, re-elected; Fred E. Fankell, new president; F. M. Hahn, retiring president; Leonard Wudel, re-elected treasurer. (Standing, L to R): directors re-elected—Art Baldwin, C. G. Skartvedt, Art Anderson, Ed Bottcher (2nd vice president), and S. L. Hjermstad. Several directors were absent when photograph was taken

Seek Program to Assure East Coast Fuel Oils, Kerosine During Winter

NPN News Bureau

NEW YORK — Efforts to formulate a program assuring the East Coast an adequate supply of kerosine and light and heavy fuel oils during the coming winter were made here this week by a 13-member East Coast Fuel Oil Industry Advisory Committee, at sessions sponsored by OPA. It was believed a series of recommendations would be formulated within a few days, since an official report is to be sent to Congress next week.

There was no attempt to minimize the seriousness of the situation among industry representatives here. Inventory of both kerosine and residual is described as "extremely tight," while supplies of distillate are only "fair." Unless some method is found whereby yield of fuel oil can be substantially increased and, presumably, yield of gasoline decreased, there is likely to be actual hardship in this area during the next few months.

Industry statistics reflecting the supply situation were to be submitted to the full committee Wednesday (Dec. 5) by a sub-committee consisting of Stewart P. Coleman of Standard Oil Co. (N. J.), A. J. McIntosh of Socony-Vacuum Oil Co. Inc., and E. T. Knight of Atlantic Refining Co. Thereafter it was expected the committee would approve a report to OPA.

Committee Members

Members of the committee, in addition to those already mentioned, include Wiley Butler, Home Fuel Oil Co.; H. B. Van Cleve, Maritime Petroleum Corp.; J. S. Worden, The Texas Co.; Joe L. Hill, Southport Petroleum Co. of Delaware; E. M. Callis, The Petrol Corp.; John P. Birmingham, White Fuel Corp.; R. A. Hunter, Gulf Oil Corp.; Harry H. Fuller. Sinclair Refining Co.; Neil Buckley, Taylor Refining Co., and D. B. Hodges, Shell Oil Co. Inc. J. H. Reppert, head of OPA Fuels Division, called the initial meeting Nov. 30, when Mr. McIntosh was elected chairman, Mr. Coleman vice chairman, and Mr. Van Cleve, secretary.

Statistics slated to be presented to the committee this week will be of particular interest, showing the first accurate picture of present and prospective fuel oil supplies on the East coast since the war ended. Both primary and secondary suppliers agree the area which formerly constituted District 1 is desperately short on kerosine and residual.

This situation is ascribed primarily to the fact that, with current price ceilings, it is far more profitable for major refineries to concentrate on gasoline, with a consequent small yield of residual and kerosine. One independent has asserted that at the present rate of gasoline production, all available storage space will be filled with gasoline by mid-January.

A Few Order Increases

Even before the committee meetings mentioned above, a few of the major companies had ordered refineries to increase kerosine output. Meanwhile, some of the independents have been declaring that unless a similar move is taken by the industry as a whole, the threat of government intervention is ominous.

An independent distributor pointed out this week that recent changes in refining methods are partially responsible for the fuel oil shortage.

"Before the war," he said, "about 26% of a crude run would end in residual. Now, with catalytic cracking, only about 14% becomes residual. The only way to increase yield of residual is at the expense of No. 2 and No. 1, and we are tight on No. 2 and desperately short of kerosine. The majors must work out their own answer to the problem."

Out-of-State Oil Men Attend South Dakota Convention

Special to NPN

WATERTOWN, S. D. — Among out-of-state oil men who attended the South Dakota Independent Oil Men's Assn. here last week were:

Hiff Horning of Northwest Petroleum Assn., and H. W. Whisman, American Petroleum Industries Committee; R. D. Hickman, Brown Tank Co.; B. D. (Doc) Dawson, Anchor Refining Co.; Paul B. Caldwell, Shell Oil; C. M. Swanson, Sinclair—all from Minneapolis.

I. B. Kingbay, Wood River Oil & Refining Co., St. Paul, Minn., was also a visitor, as were Hoyt Ogram, Kanotex Refining, and Lyle Munson, Calumet Refining, Chicago.

In revision of sales territories by Champlin Refining Co., J. A. Stohl, Milwaukee representative, has been shifted to Rock Rapids, Ia., and promoted to Division Manager. Being new in the territory, he met many of his jobber customers for the first time at the convention.

A regular attendant at the association's conventions is "oil man" Miss Viola Turriff from upstate Aberdeen. She has been manager of High Grade Oil Co.'s bulk plant there since 1937, when her mother became 68 and retired. Her father died in 1929 after running the plant for several years. It is one of seven bulk plants owned by High Grade, and Miss Turriff reports gasoline gallonage up 57% plus since prewar.

Officers Elected By Dakota Transport Assn.

NPN Photo

South Dakota Petroleum Transport Assn. at annual meeting in Watertown, Nov. 25, elected (left to right) E. F. Erling, director; J. E. Adrian, executive secretary; Willis S. Couch, president; and H. J. Wolfe, director. Others named were J. W. McKeever, vice president; Jack Nickles, secretary-treasurer; and Stanley Mundhenke, Dan Dugan, J. C. Terry, directors

M.I.O.J.A. Secretary Returns To Post, Sets Up Headquarters

JEFFERSON CITY, Mo.—Robert W. Hadlick, executive secretary, Missouri Independent Oil Jobbers Assn., has returned to resume his duties with the association after serving in the Army Air Forces for two and one-half years.

Mr. Hadlick

Offices are being set up in Jefferson City, Mo., where Mr. Hadlick will re-establish headquarters for the association.

Bob, as he is known in the industry, accepted a war service appointment as instructor in radio operating at Scott Field, Ill., in October, 1942. In April, 1943, he was inducted and after basic training at Miami Beach, Fla., returned to Scott Field to continue instructing. In November, 1944, Bob was assigned to the legal department, Plant Clearance Section, Wright Field, Dayton, Ohio. In June, 1945, he was transferred to the headquarters of the western district, Air Technical Service Command at Los Angeles where he served as recorder for the local and district Plant Clearance Boards and headed the contract unit of the Plant Clearance Section of the Western District.

Oct. 17, 1945, he received his discharge from McClellan Field, Sacramento, Calif.

Navy Calls for Peacetime Co-operation Between Oil Industry, Armed Forces; Ickes Bids for Control by Interior Department

Davies Submits Four-Point Program for a National Oil Policy; Urges Full Return to Free Enterprise System

NPN News Bureau

WASHINGTON—Outlines of a national oil policy began to emerge this week as the Senate Petroleum Resources Committee reviewed the effect of wartime practices upon the industry's peacetime economy.

As the hearings ended, these points were clear:

1. Navy wants a small but representative industry committee approved by the President to work regularly and closely with a similar group of top-level Army and Navy officials and other representatives to correlate future military petroleum requirements with those of industry, and to assure a sustained productive capacity of at least two billion bbls. per year for five years.

2. Interior Secretary and PAW Ickes wants Interior Department control of all governmental oil activities, where the U. S. has a defense or conservation interest, and governmental exploration on public lands where private operations would not be justified or where national interest requires such action.

3. Deputy PAW Davies wants a strong domestic industry, a strong overseas position, continued government-industry co-operation in peace, co-ordination of all governmental oil activities in one agency during wartime, standing Congressional oil committees, adequate price incentives for new capital, stimulation of wildcatting activities, protection for independent operators, anti-trust immunity for conservation programs, and full return to the free enterprise system.

4. PAW division chiefs unanimously favor a return to the free enterprise system, predict increased consumption of petroleum products, see a need for greater exploration, and are confident a "strong, healthy" industry will be able to meet all demands.

Navy Asks "Energetic Co-operation"

The Navy's plan, which bears approval of top Army and Navy officials, was presented to the committee by Commodore W. G. Greenman, director of Naval Petroleum Reserves, who said "sufficient doubt exists regarding the future domestic petroleum supply to require energetic co-operation between government and industry to assure the nation of enough oil, or substitutes, for its future defense."

As its primary goal, the government-industry group would have "the provision at all times of an adequate available oil supply through the operation of a vigorous and healthy oil industry working in close co-operation with the armed services, and in working toward this goal, the establishment of a continuous interchange of military and industrial information pertinent to petroleum exploration, production, refining and transportation."

The Navy believes, said the officer, "that the brains and ingenuity available to a quasi-official organization, constituted along (these) lines, can devise the means for reaching the desired goal."

Must Rely on Oil

Commodore Greenman emphasized that "for the present, as in the past," the military must rely on oil, the day when we can count on synthetic fuels being "not yet in sight" and the possibilities of using atomic energy "still far too speculative and too distant to be considered at this time."

Accordingly, he said, steps should be taken to develop and maintain proved reserves accessible to the U. S., capable of sustaining annual production of at least 2 billion bbls., for five years. He added the question of relative utilization of such production for military and for industrial purposes was immaterial "if maximum utilization for war purposes obtains."

"Prime concern" of armed services, said the Navy man is "the overall sustainable and available productive capacity of the nation's oil industry," and "no plans are being formulated for acquiring any additional naval petroleum reserves from private lands or from government lands."

The Navy's overall policy, as outlined by Greenman, is 1) correlation of future military petroleum requirements with those of industry, with industry undertaking to provide the resources to assure the availability of production ample to meet requirements for a future war; 2) vigorous pursuit of technological studies looking to determination of most satisfactory methods for economic commercial development of synthetic fuels, and 3) exploration of Naval petroleum reserves to determine their volumetric content and a sustained productive capacity.

Wants Encouragement of Industry

"In the expansion of industrial resources, both at home and abroad," Greenman said, "the government must lend all possible aid. In the field of synthetic fuels, particular encourage-

'Top-Side' Military Thinking

NPN News Bureau

WASHINGTON—Statement made to the Senate Petroleum Resources Committee this week by Commodore W. G. Greenman represented strictly top-side military thinking.

According to Capt. C. P. Franchot, Navy liaison officer on petroleum, the commodore's statement not only was cleared with all policy-making departments or bureaus of the Navy, including Secretary Forrestal, but also with the War Department, which gave assurance "that there was no divergence of views."

Secretary Ickes Appears Before O'Mahoney Committee

NPN Photo

Secretary Ickes tells the Senate Petroleum Resources Committee that he thinks the time has come to concentrate control over government oil activities in a single federal agency, meaning Department of Interior, which he heads. Listening to the secretary here are (on the left) Deputy PAW Davies, and (on right) Senator Ed Johnson, of Colo., and Chairman O'Mahoney, Wyo.

How *Wisely* Motor Trucks are Bought Will Affect How *Widely* they are Used

● Motor transport has come of age during this war. The way it has measured up to its wartime assignments assures it of an expanded role in our postwar economy.

It stands to reason that to maintain a satisfactory level of national income and jobs, we are going to have to move more goods than ever before in our peacetime history. This will call for the highest development and best use of all our forms of transportation, including trucks—and, in a sense, *especially* trucks, because all other forms require trucks as an adjunct to their own services.

To meet this challenge of expanded need, White is developing trucks of maximum efficiency—*specifically designed for the particular work for which they are intended.* In this way, the vehicle becomes an exact tool for the job at hand and obviously more efficient and economical.

By maintaining your own capable Transportation Departments, petroleum companies have long employed this principle. As a result, more satisfactory truck experience has been enjoyed than where this professional approach was not taken.

If motor transportation is to measure up to its full possibilities postwar, all truck owners must be convinced of the soundness of this approach to their problems of proper truck selection and operation.

White earnestly believes that motor transportation's best interests for the future lie in this direction and welcomes the petroleum industry's continued support of it.

J. W. Bauman

Vice President
THE WHITE MOTOR COMPANY
Cleveland, Ohio

FOR MORE THAN 45 YEARS THE GREATEST NAME IN TRUCKS

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Remarks of Deputy PAW Davies are followed intently as he outlines "four cornerstones" of a national oil policy to the committee. Sen. Gurney, of South Dakota, is to right of Mr. Davies in the picture and H. Chandler Ide, Mr. Davies' aide, is to left. Seated against map in background can be seen (between Mr. Ide and Mr. Davies) Max B. Ball and Adolph Levy, both of PAW, while gentleman with horn-rimmed glasses is Faye te B. Dow, general council of National Petroleum Assn.

ment must be given industry by the government to stimulate technological development, and as required, to the construction by private enterprise of facilities to insure production ample to supplement or replace petroleum products.

"In return it will be incumbent upon industry to co-operate by giving concrete assurance of its ability on short notice to provide the oil or its substitutes in ample quantities in time of emergency."

As for efforts to obtain desired overall available productive capacity, the officer said they should be concentrated first, within continental limits of U. S., including Alaska; second, within boundaries of contiguous countries; third, in remainder of Western Hemisphere, and last, in other areas of world. Intrinsic military value of such reserve capacity, he stated, "decreases in the order indicated because of obvious reasons of distance, political differences, vulnerability to attack, etc."

Enlarged production of foreign oil, however, he continued, can make "the largest contribution" to conservation of domestic resources "by lightening the burden upon them."

"It is not meant by this," he emphasized, "that oil should be imported into this country if such importation results in any diminution in the incentives that should exist here to encourage the search for oil or in any narrowing of those profit margins that furnish the funds for vigorous domestic exploration. It does mean however, that American nationals should be encouraged to supply their foreign markets from foreign sources and to find new sources of oil within the boundaries of the nation to supply the domestic demand."

Ickes Bids for Interior Control

Secretary Ickes, pointing out that the nation is confronted with enormous demands for liquid hydrocarbons and known reserves cannot supply these demands for any protracted period, said the situation called for creative efforts along four lines:

1. Stimulation of exploration, so as to transform "potential" or unknown reserves into known or proved reserves—in other words, getting new sources of productive capacity.
2. Efficient use—making what is "known" last longer.
3. Encouraging further advancement of technology in finding and developing petroleum resources and in the art of refining, as well.
4. Assuring ourselves of access to foreign oil resources to supplement our domestic resources, as needed.

The secretary put in his bid for Interior Department control of all governmental oil activities with an assertion that "we ought to entrust to a single properly equipped agency the management and control, where our government has a defense or conservation interest, of all petroleum matters affecting that interest."

He emphasized that he wanted it "distinctly understood" he was "not even hinting that there should be general government control, least of all management" of private industry, and added:

"But every man who knows enough to bring up a barrel of oil from the ground knows that the production and use of that oil in times of emergency such as war may become affected with a pressing public interest."

Outlining his views as to what form our national oil policy should take, Mr. Ickes said the oil industry had done a good job and that the job should continue to be done by private enterprise "to the fullest extent that this may be possible." But he saw no inconsistency, he continued, in asserting that government "must make certain that, for whatever needs the future may bring, it will have all of the oil that it requires, where it is required, and when it is required."

Mr. Ickes described government as the largest single owner of known and prospective oil land and said this fact "coupled with its concern for a stable oil industry," requires that it take an active part in aiding and encouraging search for new fields and establishing sufficient reserves to constitute a safety factor in wartime.

Accordingly, he said, any revision of public land leasing laws should also permit federal government "to participate in the exploration of its own land," particularly in regions where private operations would not be justified or where national interest requires such action.

Urges More Research

Mr. Ickes also urged intensification of research work in synthetic fuels field and, discussing foreign oil developments, said he "would have not the slightest desire or intention of suggesting that the government foreclose" opportunity of

Charts Prepared by PAW

Charts appearing on pages 17, 19 and 22 are among those prepared by the Petroleum Administration for War to illustrate the testimony of PAW officials before the Senate Petroleum Resources Committee, of which Senator O'Mahoney (D.-Wyo.) is chairman.

Davies Would Keep WAC Out Of Oil Business in PRC Charter

WASHINGTON — Deputy PAW Davies is hopeful the Petroleum Reserves Corp. charter will be altered so as to prevent War Assets Corp. which has taken over PRC, from doing any oil business. Mr. Davies said the charter, as it now stands, "only breeds suspicion and distrust."

American industry to expand its holdings and business abroad.

Secretary's bid for Interior Department control of governmental oil activities was prompted, he said, by war-proven fact "that in war or peace the U. S. has only one oil barrel."

"We found out by bitter experience," he told the committee, "that it does not make sense to operate under a lot of conflicting jurisdictions and regulations that clash and bewilder harassed individuals and confound an oil industry willing to co-operate with a government at bay to defend a continuance of our democratic system.

"Why pretend that there are such separate items as civilian oil, war plant oil, transport oil, Air Force oil, Army oil and Navy oil all wrapped up into separate packages and carried about by different red-caps? Will someone please tell me why it makes sense in this age of total war to operate naval petroleum reserves that were set up, without much foresight, for the exclusive use of our Navy and make no similar provision for our modern Army and Air Forces? Is our Army of today supposed to run on oats and our Air Forces on hay? What we need is a national policy, devoid of departmental acquisitiveness and having regard for the oil needs of the armed forces of the nation as a whole.

"This shortsighted policy failed under the crucial test of war. We were under the necessity to ignore it and adopt the concept of one national oil barrel to fight the war, run the war plants, and sustain the civilian economy until we achieved victory. By force of circumstances in this war that single oil barrel was the Petroleum Administration for War that is now in liquidation. It fueled the Navy, the Army, the Air Force, the war plants, sustained the national economy and performed many other tasks, as well as providing a willing and patriotic industry with a single and reliable G. H. Q., with which to work and save that industry from wandering bewildered through a maze of governmental agencies.

"But the problem that required that policy in the recent past remains with us in the immediate future and is unescapable if we have a regard for our security. This is why I say to you that the time has come to recognize that we have only one national oil barrel which means that we ought to entrust to a single properly equipped agency the management and control, where our government has a defense or conservation interest, of all petroleum matters affecting that interest."

Davies Has 4-Point Plan

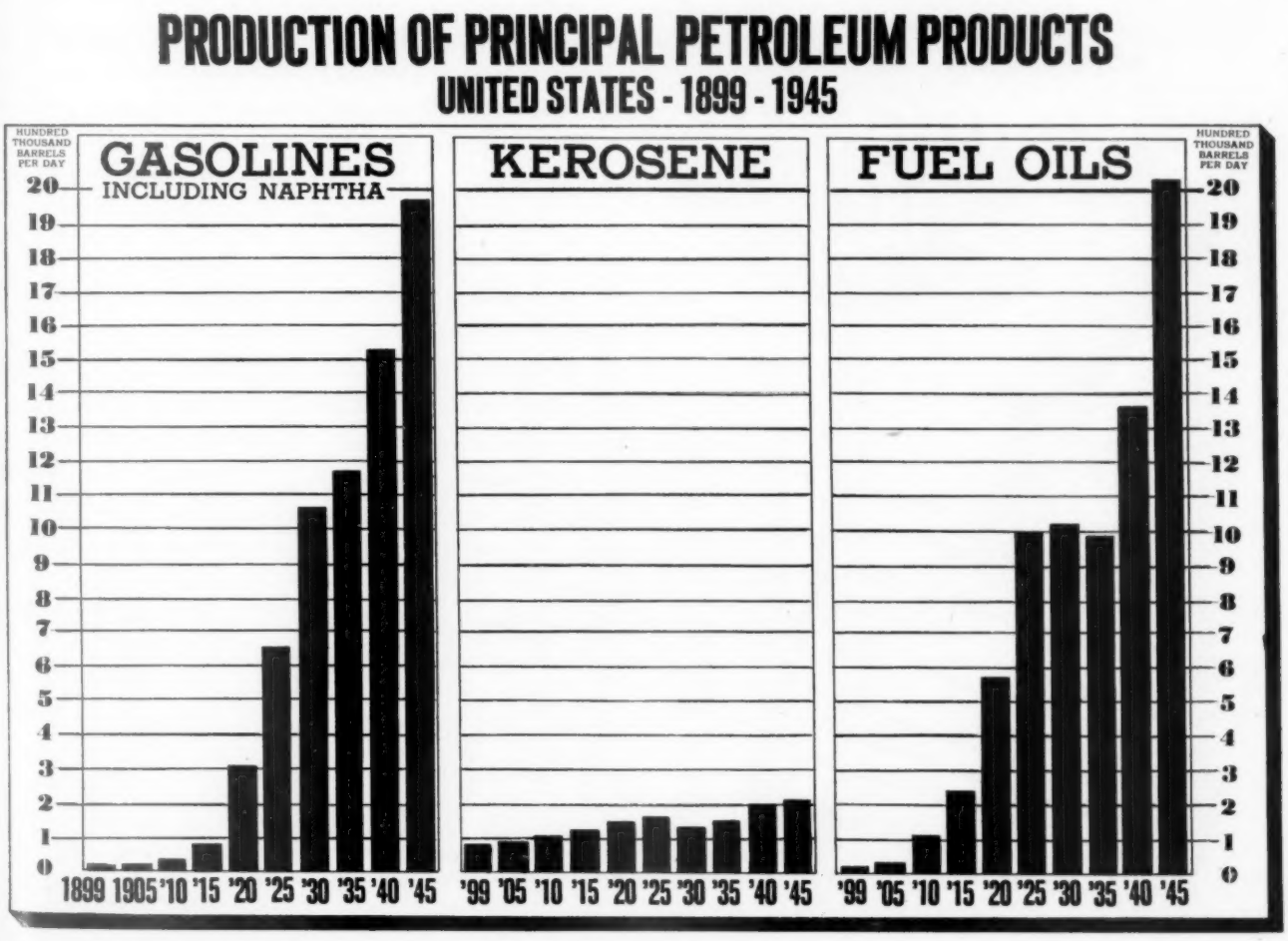
Deputy PAW Davies, who urged adequate conservation measures and a program of "dynamic exploration" to reverse the downward trend of discovery in his opening statement Wednesday, presented the committee with four cornerstones for a national oil policy in his concluding summary Friday.

The four main points presented by Mr. Davies were 1) a strong overseas position, 2) a strong domestic industry, 3) continued Government-industry cooperation for peace, 4) coordination of all Governmental oil activities in one agency during wartime.

In addition, Mr. Davies recommended the committee be given permanent status, asserting that "the importance of oil in the national welfare calls for a standing Senate oil committee that may keep constantly informed upon the subject of petroleum and continuously available to the executive departments and to the public as need for congressional interest in this field shows itself."

Commenting on government-industry cooperation for peace, Mr. Davies repeated his statement to the A. P. I. convention that "there is nothing in the law to discourage the existence of an industry body to counsel and advise with the Federal government upon oil matters, either upon its own motion, or as the government may request such counsel and advice."

Upon questioning, Mr. Davies said he was seeking "a means by which the industry can make known through one


PRODUCTION OF PRINCIPAL PETROLEUM PRODUCTS
UNITED STATES - 1899 - 1945
GASOLINES
INCLUDING NAPHTHA
KEROSENE
FUEL OILS
HUNDRED THOUSAND BARRELS PER DAY
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
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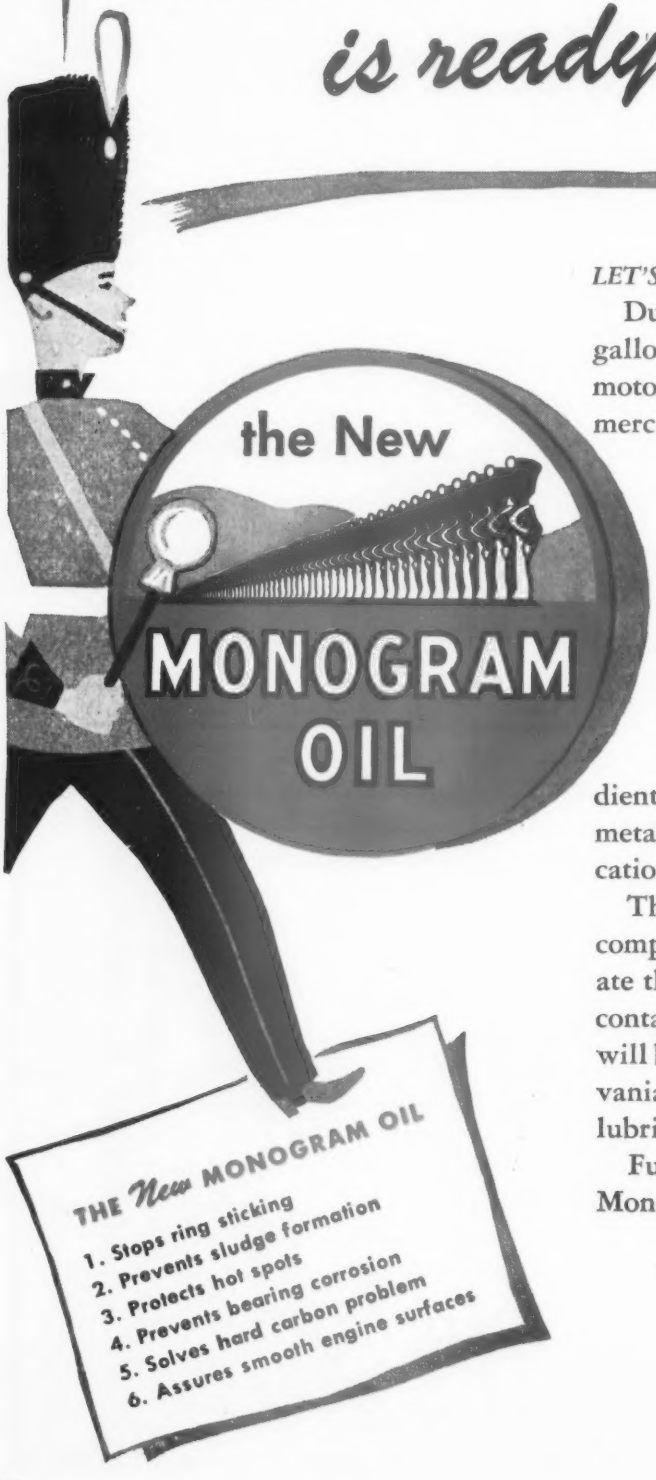

LET'S LOOK AT THE facts about the *new* Monogram Oil.

During the war years, we manufactured millions of gallons of high grade lubricating oils for Army and Navy motorized equipment and for essential, heavy duty commercial vehicles. This was *special* oil . . . designed and *engineered* to make engines last longer and require fewer service operations and repairs.

This *special* oil contains an additive compound composed of several different types of ingredients. Each ingredient performs a distinct function . . . one is a powerful, yet safe detergent; another is an inhibitor against formation of sludge, gum, carbon and corrosive acids that naturally form in all internal combustion engines; and still another ingredient is a specific oil that has a natural attraction for metal. Combined, they form *the additive* that made lubrication history during the war years.

The intimate knowledge of just how well this specific compound performed brought about the decision to create the *new* Monogram Oil . . . and now *all* Monogram contains this same type additive. The motoring public will be quick to recognize the advantages of fine Pennsylvania oil plus the additional benefits built into this *better* lubrication.

Further information about the *new* Monogram and the Monogram franchise will be sent on request.

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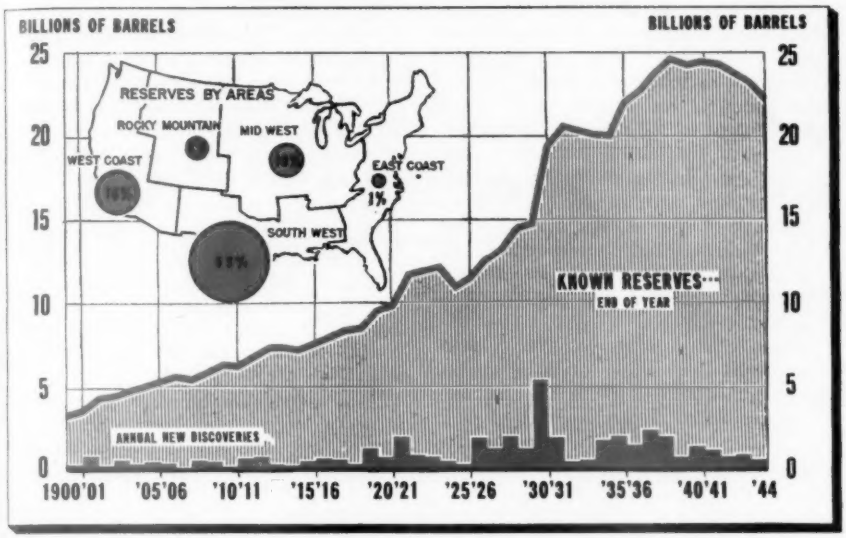


source what its problems are and what the facts about oil are, the facts that government should have before it determines policy." Then he added:

"That would be perhaps patterned somewhat on what we have had during the war, which has been a Petroleum Industry War Council, a council representative of all branches of the oil industry and all elements of the oil industry, a really representative body with which the government could deal."

Mr. Davies said he was hopeful the industry would see more merit in creating something comparable to P.I.W.C. for use in the peace period, and that on the government side some arrangement would be set up which would coordinate intra-governmental oil activities, causing a better job to be done within the government, and which, along with that, would be prepared to receive the counsel of the oil industry on oil matters.

The PAW executive said concentration of all governmental oil activities in a single agency would be impracticable as to most of them and undesirable as to the rest. He said, for example, the oil and gas unit of Bureau of Internal Revenue could not well be segregated from the other tax work of the bureau, nor should the excellent oil and gas mapping and stratigraphy done by the Geological Survey be divorced from its other geologic work.

"It is obvious, however," Mr. Davies asserted, "that no coherent government-industry relationship could be established or maintained by the independent contact of the industry with each of these agencies. Somewhere, somehow, there must be a recognized channel through which the knowledge, judgment, and desires of the government may flow to the industry."

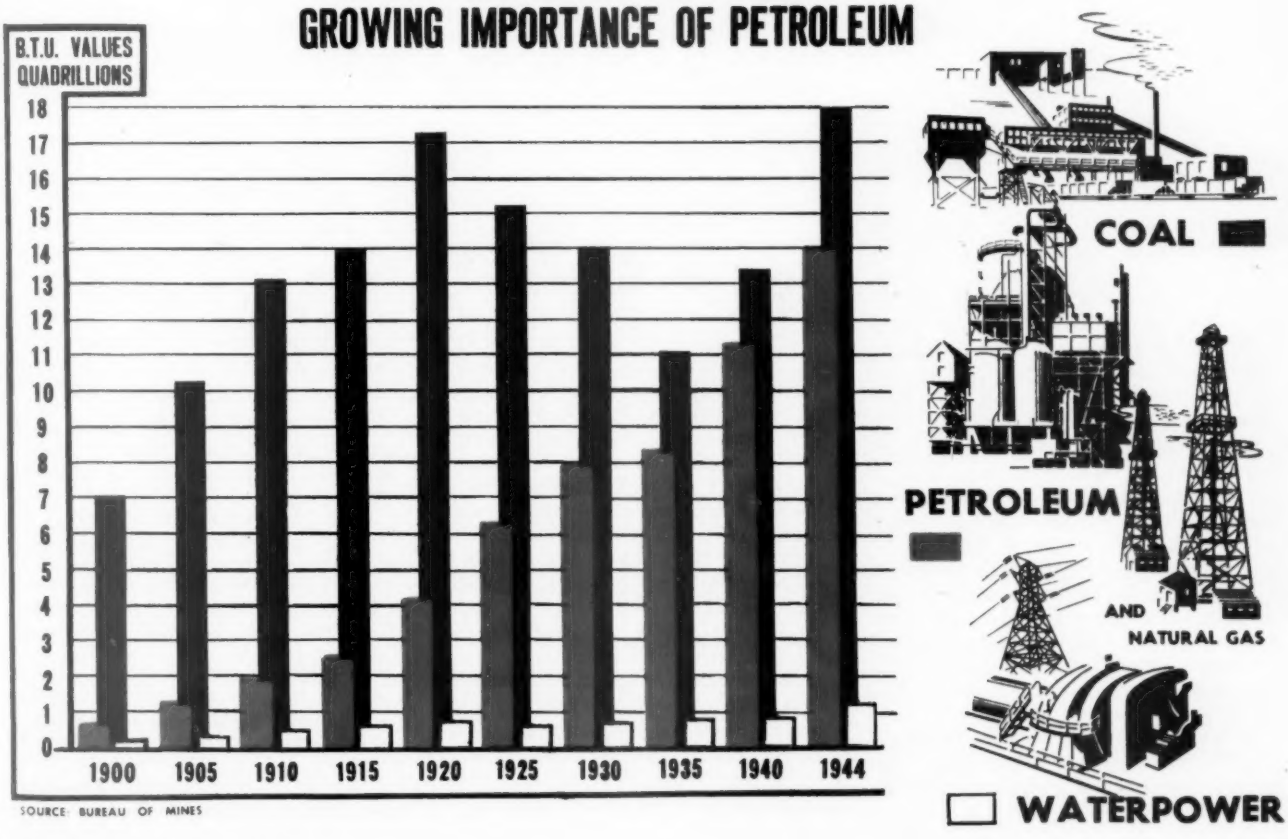
Davies said he was not prepared to suggest the specific form of such a channel, and added that he was suggesting only the need for improved administration and greater efficiency as applying to the present activities of the government—not more government in oil.

Cites Need for Capital

Citing the need for a strong domestic industry, which he said the domestic economy and national security both demand, Mr. Davies gave as one requisite a continuing flow of investment capital into the industry, and particularly into new small enterprises.

The oil business has always attracted an adequate flow of new capital and doubtless will continue to do so, so long as the price of oil offers capital an

U.S. SOURCES OF ENERGY
GROWING IMPORTANCE OF PETROLEUM



SOURCE: BUREAU OF MINES

adequate incentive for the risk incurred, Davies asserted.

"Capital will not flow into new oil companies," the PAW official declared, "unless the price of crude is such that he who makes even a small discovery stands to make something more than a merely modest return."

Davies remarked that throughout PAW's presentation witnesses have called attention to termination of all restrictive controls, and may have said that the industry has been restored to its normal competitive state in a free economy.

"So far as PAW restrictions were concerned, it has been so restored but an industry is not functioning as part of a wholly free economy, when the prices of its raw material and its manufactured products are not determined by free competition.

"That such a situation, partly free, partly controlled, may be less advantageous than full control or full freedom is suggested by the threatened shortage of kerosine in parts of the northeast. The price of kerosine, we are told, does not induce the refiners to make more kerosine at the expense of gasoline, which brings a higher price. Under wartime controls we could have directed them to do so. Today neither controls nor price incentives are in operation to augment the kerosine supply," he commented.

Mr. Davies said that, in his opinion, control over oil prices should be terminated as soon as adequate supplies are available and overall government policy admits. He said the first prerequisite appears now to be satisfied but as to the second, "I don't feel I am in position to judge."

Lauds Independents

Special importance was attributed by Mr. Davies to the independent operator, whom he credited with making the American oil industry great.

"If the American oil business," he said, "had been a single great company or a score of great companies, it would not have discovered half as many fields, or built half as many refineries and pipelines, or installed one-tenth as many filling stations—nor, incidentally, would its products be at anything like their present low price or high quality."

He added that the multitude of small companies was the "best insurance of the continued freedom of the American industry, since herein lies protection against monopolistic trends and consequent government control."

Mr. Davies said the small operator and the domestic industry should be protected continuously against too much imported oil. While not making specific suggestions concerning the form of this protection, he said the import duty:

1. Should be high enough to insure a crude price that will encourage domestic exploration, development and production.

2. Should be high enough to foster the development of productive capacity adequate for the national security.

3. Should not be so high as to relieve the domestic industry of incentive to lower production costs, or to drive overseas all refining of foreign crude to make products for export, or to result in high prices to the American consumer.

Turning to foreign oil, Mr. Davies said a policy must be rooted in an informed public opinion and include such things as equality of opportunity for American citizens, and insistence on international, fairness toward our nationals. In addition, it must be consistent and permanent to have any value.

In event of another war Mr. Davies recommended a single civilian agency with responsibility for all the nation's oil requirements, an agency staffed from the industry, having a comprehensive scope and adequate charter, and exercising a minimum of coercion.

Oil's Importance to Grow

Looking into the future, he predicted any changes which may develop are likely to increase rather than decrease the importance of oil and gas. He said the indirect effects of utilization of atomic energy should all be favorable to the oil business, because an atomic age will be more and more a machine age and because cheaper energy will bring to the market a growing list of new products which will be or will contain hydrocarbons, readiest sources of which are oil and gas.

"Thus both the direct and the indirect effects of the use of atomic power," Mr. Davies said "may hasten the day when the non-fuel uses of oil exceed the fuel uses in importance. Because the non-fuel uses are in the main the higher-priced uses, the net effect is likely to be an increase rather than a decrease in the economic stature of the oil business.

"Whether the peacetime uses of atomic energy come quickly or slowly then, its development is less likely to wipe out the oil business than to increase its importance. Meantime, oil will continue to grow in importance as a source of both fuel and non-fuel products. Both before and after the widespread use of atomic energy, therefore, the value of the oil business in American and world economy should continue to grow."

Following are highlights from Mr. Davies earlier testimony, presented to the committee on Nov. 28:

"Such a job could only be done by a vast and vigorous industry, guided and assisted by a government agency experienced in the industry's operations and problems.

"The petroleum industry is America's second largest business. PAW was staffed with men who knew the oil business, most of them drawn from the industry, backed by the authority of the government and with the government's knowledge of world-wide needs. The industry and PAW were a closely-coordinated team, the combined task force of the oil campaign. The key to the war's oil achievement lay in their teamwork and in the co-operative organization that made its effectiveness possible. Their government-industry partnership was unique—and it worked."

* * *

". . . The only safe course, if the downward trend of discoveries is to be reversed, is to drill more wells in dynamic exploration."

* * *

"The most effective stimulus, of course, is an adequate price for crude. Eighty-one per cent of the wildcat wells drilled in the United States last year were dry. To induce enough individual operators to face adverse odds of four to one, the price of crude must be such that the man who makes even a small discovery can expect something more than a modest return.

"It is true, as has been pointed out, that a higher crude price does not lessen the odds against the wildcatter; what a higher price does is to enhance his prospective reward. Whether he operates his discovery or sells it, it gives him more money to go on to the next chance. It likewise makes outside capital easier to obtain. Anyone who has raised money for wildcatting knows how much more easily it can be had when the price of crude is up rather than down.

"Why, then, during the war years, did wildcatting increase despite a virtually static price? There were at least three reasons:

"THE INDUSTRY responded to PAW's appeals to maximize exploration.

"MANY WILDCAT wells were drilled by high-bracket taxpayers because most of their cost would otherwise have gone for taxes.

"THE RELATION between supply and demand convinced the industry that higher prices were sooner or later inevitable."

* * *

"The small operator has always discovered a fair share of the new oil; he will continue to do so as long as he is

Ickes Wants Naval Reserves; Navy Wants to Keep Part

NPN News Bureau

WASHINGTON—Secretary Ickes wants control of the Naval petroleum reserves placed in the Interior Department, and the Navy says it won't give them up—at least not entirely.

This conflict in views was made plain this week to the Senate Petroleum Resources Committee, with Com. W. G. Greenman stating flatly that the Navy has no idea of giving up administration of the reserves, meaning No. 1 (Elk Hills) in California and No. 4 at Point Barrow in Alaska.

It's different, however, with respect to Teapot Dome (in Wyoming) and Buena Vista (in California), said Greenman, the former being of "no value" and the latter being "completely under production."

"Never thought you'd cut shipping costs that much. How did you do it?"

"A cinch, chief. We're using that new Sullivan Box for canned oil!"

Cut shipping container cost for canned oil to as little as 3¢ per 24 quart cans shipped

That's right . . . you can cut your shipping container cost to as little as 3¢ for every 24 quart cans shipped by using the wooden box illustrated at the right.

How come? Because tests made by major oil companies prove that this same box can make up to 34 round trips between refinery and dealer. This tough, reusable wooden box costs only $1.01 in 100,000 quantities. $1.01 divided by 34 figures a fraction less than 3¢ for every 24 quart cans shipped!

We'll be glad to send you a sample without obligation. Examine it—test it—then compare the cost with any other type of shipping container you might now be using.

IMMEDIATE DELIVERY! Strong, reinforced wood construction. Holds 24 qt. cans. Reusable lid with patented easy-open toggle latch that requires no special tools.

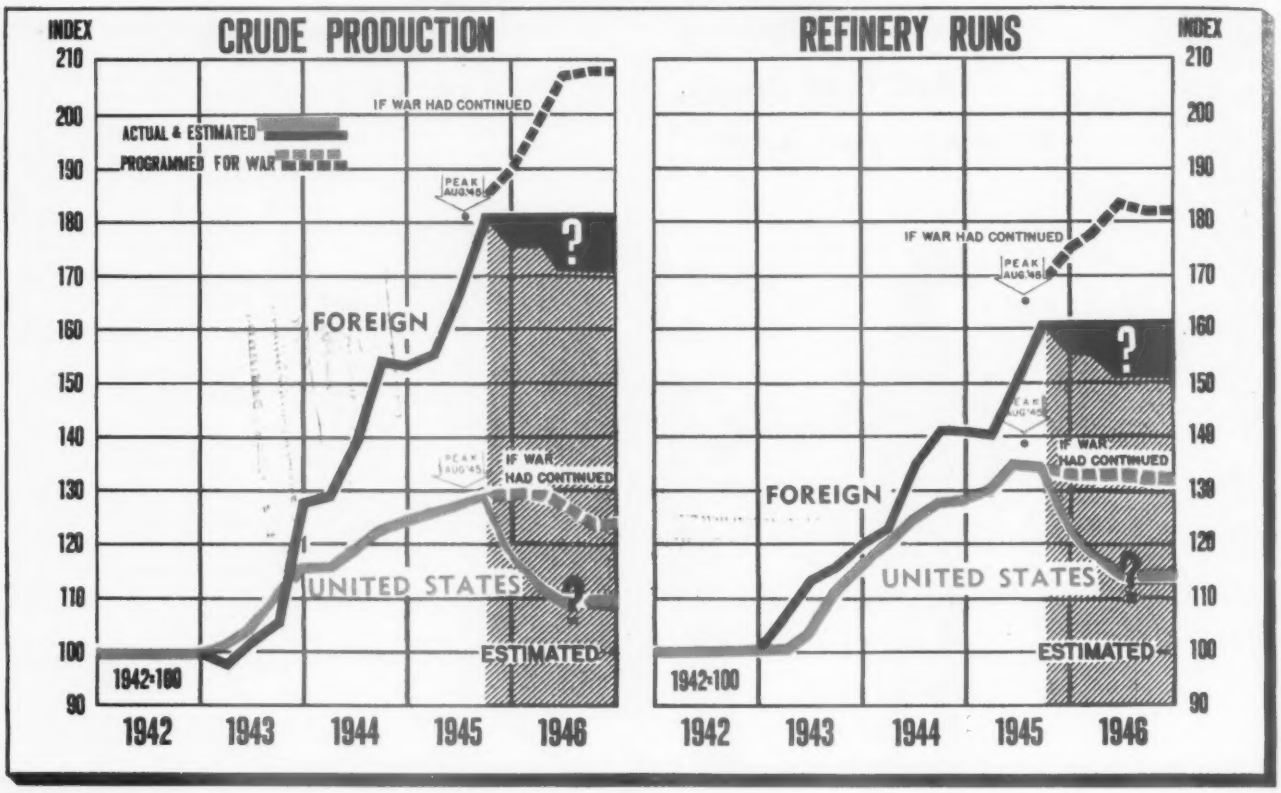
Write for sample and prices, without obligation.

SULLIVAN BOX FACTORY

SULLIVAN BOX FACTORY

Sullivan, Illinois
PHONE: L. D. 7

INCREASE IN PETROLEUM PRODUCTION AND REFINERY RUNS
UNITED STATES VS. FOREIGN•



•EXCLUDING AXIS & SOVIET AREAS

given a crude price that will keep him wildcatting."

* * *

"I believe in the control by each state of the resources within its borders. I should oppose any extension of federal regulatory authority to such resources unless all other means fail to prevent practices injurious to the national welfare and the citizens of other states. One cannot blink the fact, however, that the waste of oil within any state may affect the availability or price of oil products to the residents of other states. The negligence of California, for example, might—and in time probably would—cause the citizens of Oregon and Washington to pay more for their gasoline and fuel oil. Such a situation puts a limit on the right of a state to do as it will with the resources that Nature has placed within it."

* * *

"In Illinois, in the years before the war, the waste of reservoir energy and the quantities of oil rendered unrecoverable at reasonable costs were appalling. California avoided the worst evils of unrestricted production by voluntary proration, but voluntary conservation has a glaring weakness: it requires unanimous co-operation and compliance. Thus a voluntary conservation program is at the mercy of any reckless or greedy operator who may choose to violate it.

"Many operators today, moreover, hesitate to join in a voluntary conservation program because of fear of prosecution under the anti-trust laws. Remembering certain suits instituted not so many years ago, such fears cannot be brushed aside as wholly groundless.

"The cause of conservation might be measurably advanced, and I can think of no way in which the public interest might be impaired, by a statute relieving from the operation of the anti-trust laws agreements entered into among operators for the purpose of preventing waste of oil or gas. Again, the determination of the true purpose of the agreement and the definition of waste could safely be left to the courts, with no need to fear that they would permit abuse of the protection given by the statute."

* * *

"Some people have wondered why even more oil was not taken from foreign fields and less from home sources. The reasons were purely physical and geographical and never, in any sense nationalistic. Foreign fields carried as much of the war load as their productive and refinery capacity, available pipeline outlets, and location with respect to points of need permitted. Our efforts to increase available foreign output received the whole-hearted co-operation of the British and the nations in which the fields are located. At no time was there the slightest holding back by our Allies, the slightest reluctance to develop or deplete fields that they control."

* * *

"The present large reserves per well and high capacities per well in foreign areas are due in part to two causes:

"THE FOREIGN FIELDS have developed under unit operation, with no need for competitive drilling, over-production or waste of reservoir energy.

"FOREIGN EXPLORATION has had the benefit of modern geologic,

Problems of Independents Senate Group's Next Subject

NPN News Bureau

WASHINGTON—Next subject of the Senate Petroleum Resources Committee will be problems of the independent company, including an analysis of problems incident to operation of an independent company in exploration, transportation, refining, and marketing, relationship of the independent to the integrated company, and application and operation of anti-trust laws in respect to their functions.

Hearings are expected to begin in January. Ralph T. Zook, past president of Independent Petroleum Association of America, is chairman of the industry group which will make the presentation.

Trucks that fit the job:

Many gasoline and oil marketers use Dodge *Job-Rated* trucks because they do a *better* job, save money, and last longer on the job!

1. DO A BETTER JOB!

Dodge *Job-Rated* trucks, powered and sized throughout *to fit your job*, do a *better* job than trucks either too big or too small.

2. SAVE MONEY!

They save on gas, oil, tires and maintenance . . . with that ECONOMY for which Dodge vehicles have been famous through 30 years.

3. LAST LONGER ON THE JOB!

Dodge *Job-Rated* trucks, built to high Dodge standards of quality and precision, *last longer*, and operate more efficiently throughout their longer life!

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DODGE *Job-Rated* TRUCKS

geophysical and production engineering practice applied in the early stages before the easily discoverable fields had been found and depleted.

"After giving full weight to these factors, however, a third and highly-important factor remains:

"CERTAIN FOREIGN areas, particularly in the Middle East, appear to contain more oil per 1000 square miles than most of the productive parts of the United States. Beyond all question, vast foreign areas not yet explored, as well as areas already under exploration, will be highly productive.

"For the sake of the American economy and of future American security, nothing should be left undone to promote full participation by American interests in the development of these areas."

* * *

"With the emergency past, over-all scheduling enforced inter-plant and inter-company shifting of crude and components, and compensation for uneconomic movements have given way to open market transactions and competitive practices. The refiner's objective is again better quality at lower cost than his competitors.

"Against such a day, now happily arrived, PAW was watchful not to impair, if it could be avoided, the competitive position of any refiner, large or small. Its success is indicated by two facts:

"MORE SMALL REFINERIES were running at the end of the war than before, and the throughput of small plants increased more after Pearl Harbor than in the preceding six years.

"THE PUBLIC BENEFITS of the wartime program will not be confined to enlarged facilities for making better products. Refining has gone far beyond prewar conventional practice: it is producing new fuels and new lubricants as well as a host of special products of which high octane gasoline, butadiene and toluene are only examples."

* * *

"It would not do to assume, moreover, that the 'dry' gas remaining after the removal of liquefied products and special components has only direct fuel value. The time appears to be approaching when gasoline may be synthetized from 'dry gas' at costs competitive with those for producing gasoline from oil. Such a development may add greatly to our domestic reserves from which motor and aviation fuels will be available at reasonable costs."

* * *

"The future of the 'Big Inch' pipelines is being studied by government agencies, the industry and the Congress. Some perplexing questions are involved. I have no ready answers, but a few observations may be helpful.

"The lines were not built or needed to serve a peacetime economy; they were built for a single purpose, to meet a great war emergency. They have served that purpose; they helped to win a war that would have taken much longer to win without them. They have repaid in money a large part of their cost; in service rendered they have repaid their cost many times over. In considering their use or disposition, therefore, they need not be looked upon as owing us anything.

"The question whether the lines should be kept intact against a possible future war is a difficult one, and one that materially affects possible civilian use. It can only be answered by those in position to estimate the chances of such a war, the theaters in which it will be fought, its fuel needs and the availability of tanker capacity. I might suggest, however, that a war more than a few years hence might have new and different fuel and transportation needs, and that we might do the nation a grave dis-service by thinking of such a future war in terms of the one just past."

Declares 'Subnormal' Crude Prices Hurt Texas Income

Special to NPN

DALLAS—Texas has been deprived of $1,500,000,000 in income during the war by "subnormal" prices on crude oil set by OPA, D. Harold Byrd of Dallas, president of the Independent Petroleum Assn. of Texas has alleged.

"The state's economy as a whole would have benefited by the $1,500,000,000 which it should have received for the oil produced during the war. The farmers, ranchers, landowners and other royalty owners would have received $217,000,000 of it. The state treasury would have been enriched through additional taxes on oil by $62,000,000, of which the public school fund would have received more than $15,000,000," he declared in a letter to the Texas congressional delegation.

"All other commodities brought an average price above normal. Crude oil, the largest factor in Texas economy, brought a wartime average of less than $1.22 a bbl., contrasted with a normal value of $1.85."

'Temporary' Line Drawn For Rehiring of War Veterans

NPN News Bureau

WASHINGTON — National Selective Service System headquarters announced last week returned veterans do not have re-employment rights if they left "temporary" war emergency jobs for service in the armed forces.

The Selective Service interpretation was made in connection with various reports employers had endeavored to fix a certain date on which their war activities began and thus claim all employes hired after that date were "temporary" employes and not eligible for statutory re-employment rights.

Selective Service said no such date could be fixed as a criterion as to whether or not the employe was "temporary" before entering military service and, therefore, constitute a basis on which he might or might not claim statutory employment rights.

FTC Wants to Know Why Detroit Order Hurts Independents

Special to NPN

CHATTANOOGA, Tenn.—The Federal Trade Commission has asked the National Council of Independent Petroleum Assns. to specify reasons for believing that the FTC order against Standard Oil Co. (Indiana) in the Detroit case (Docket 4389) may have an adverse effect upon independent jobbers.

N.C.I.P.A. expressed its concern about the order in a letter to the commission Nov. 16. H. L. Thatcher, president of the council, received the following reply:

"The commission has received and considered your letter of Nov. 16. It is noted that you believe the commission's order may adversely affect thousands of independent marketers of petroleum products throughout the nation to such an extent that they may be forced out of business.

"If you will submit a written statement specifying the reasons for your belief the commission will be glad to give it appropriate consideration. You may be sure that no such adverse effect as you indicate was intended by the order."

Copies of the letter have been forwarded to members of a committee of five which was appointed at the N.C.I.P.A. meeting in Chicago Nov. 15 to study problems raised by the Detroit order. Members of the committee are: Eric V. Weber, Ohio; O. J. Shaw Nebraska; R. J. Rogers, Indiana; Harry B. Hilts, New York; G. A. Primm, Illinois. The committee later will meet to agree upon the next steps to be taken.

Indiana Standard Asks FTC For Extension of Time

NPN News Bureau

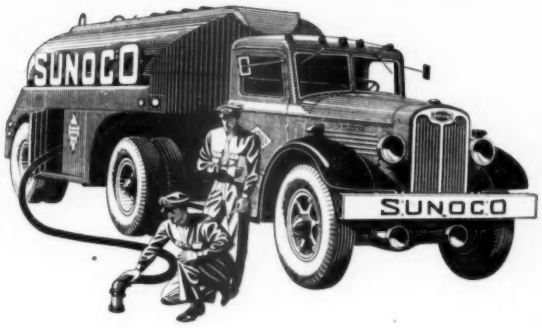
CHICAGO—Standard Oil Co. (Indiana) asked FTC Nov. 30, for an extension of time within which it must comply with the commission's Oct. 26 order requiring company to discontinue selling gasoline to jobbers or wholesalers in Detroit unless the latter will agree not to resell the gasoline to service stations below price company sells to service stations direct.

Order requires company to report compliance by Dec. 26, but in motion filed Friday Standard is asking for more time in which to decide whether to comply or to ask the commission or the courts to set the order aside or modify it, company announcement stated.

Four Natural Gas Hearings Set by FPC Early in '46

Special to NPN

DALLAS—The Federal Power Commission natural gas investigation hearing which was to have been held here Dec. 10, will be held in Houston Jan. 28. Three additional hearings are set for Feb. 11 at Biloxi, Miss.; Feb. 19 at Chicago; March 19, at Charleston, W. Va.



ON THE JOB AGAIN

Full-capacity production for commercial use. That's where we stand today. That's where we *want* to stand, for heavy-duty Autocar Trucks are superbly engineered and precision-built for private enterprise. And private enterprise needs Autocars . . . low-cost-per-mile performance, for money-making dependability, for money-saving stamina. Autocar Trucks cost more *because they're worth more* . . . and no one knows this better than the nation's leaders who have demanded Autocars beyond our immediate ability to supply them. Buy Autocars—*by* Autocar. Follow the leaders, for they know the way.

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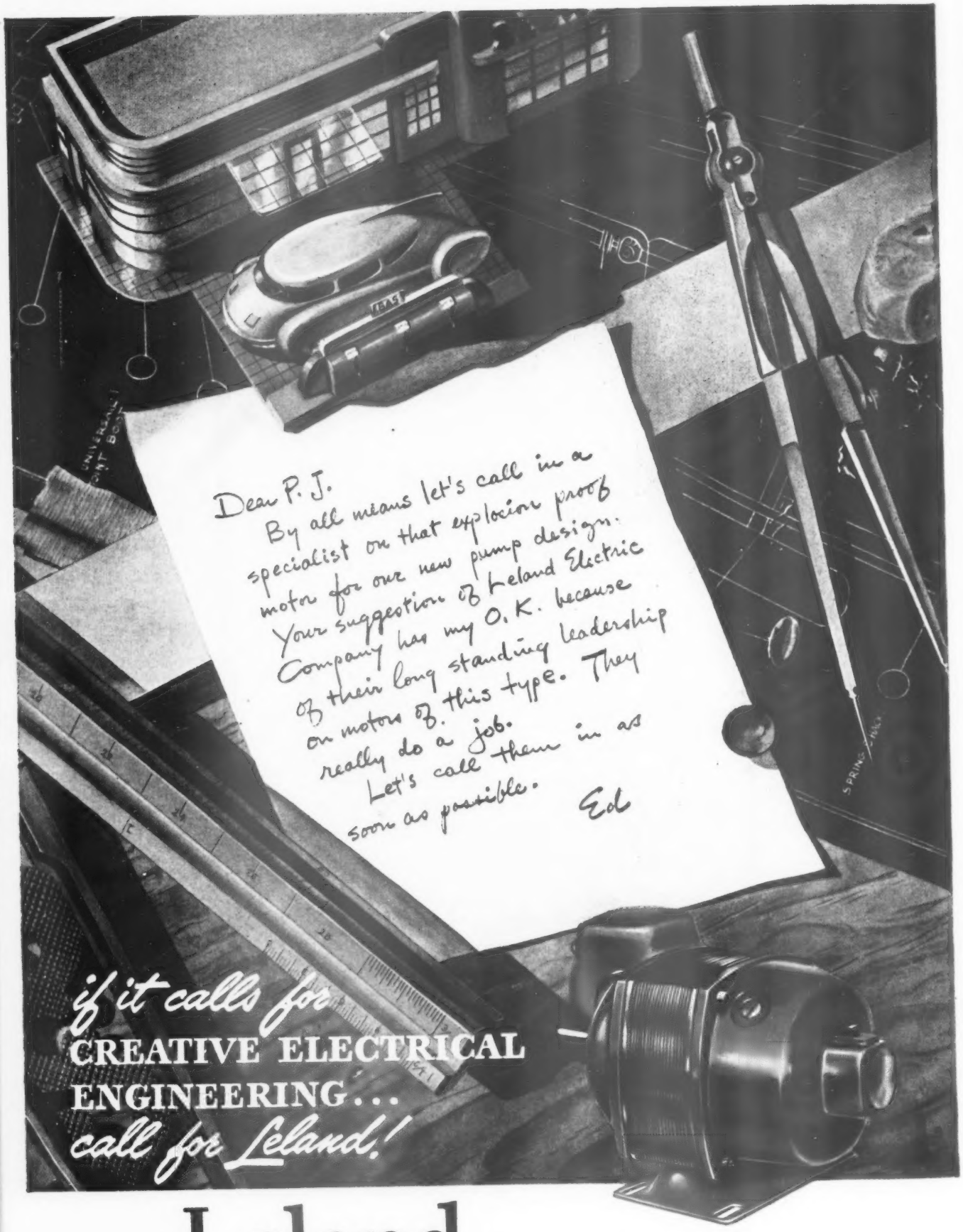
MANUFACTURED IN ARDMORE, PENNSYLVANIA
SERVICED BY FACTORY BRANCHES AND DISTRIBUTORS
FROM COAST TO COAST


Dear P. J.
By all means let's call in a specialist on that explosion proof motor for our new pump design. Your suggestion of Leland Electric Company has my O. K. because of their long standing leadership on motors of this type. They really do a job.
Let's call them in as soon as possible.
Ed
if it calls for
CREATIVE ELECTRICAL ENGINEERING...
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The Automobile Is No Luxury Today--Life in America Depends on Motorized Transportation in Peace, War

Global Conflict Left Its Imprint on the Progress of Automotive Development; In Peace the Swelling Tide of Autos Inspired Building of Streamlined Highways

How America came out of the mud, how America learned about her own beauty, how America fought a motorized war—all are recounted in the second and concluding part of Franklin M. Reck's "A Car Traveling People", sequel to the article appearing in National Petroleum News last week. From a congressional report, Mr. Reck's survey of machine-age United States, grew into this highly-interesting history of the changes the automobile has wrought in the western hemisphere—in the most mechanically-minded nation in the world.

The Reck study has been considered almost a sociological study, for it includes in the breadth of its wide view of a changing land, the individual impact of motor transportation on the life of the farmer, the business-man, the salesman, the preacher, and the traveler. Its scope can best be expressed in the words of Robert S. and Helen Merrell Lynd whose book "Middletown" epitomizes the sociology of America:

" 'Why on earth do you need to study what's changing this country?' said a life-long resident and shrewd observer of the Middle West. 'I can tell you what's happening in just four letters—A-U-T-O!' ".

We've known for some time that the automobile is no luxury. The Bureau of Labor Statistics lists the car, along with food, shelter, and clothing, as a necessity of life. How great a necessity it has become is revealed by highway surveys begun in 1936 by the state highway departments in co-operation with the Public Roads Administration. These surveys have told us precisely how people use their cars.

A special analysis of six states informs us that wage earners travel 7,657 miles a year against an overall average of 8,139. Seven out of ten workers surveyed use their cars regularly to go to work. The bulk of them made between 200 to 400 round trips per year to work, averaging 8.8 miles per trip. The wage earner's wife, mostly on Saturdays, did the family shopping, averaging six miles per round trip. This picture of the wage-earner's car tells us why the time-honored pattern of a mill surrounded by workers' homes is slowly disappearing from the face of the nation.

Doctors use their automobiles more than any other occupational group with the exception of traveling salesmen. The doctor travels 12,932 miles a year, averaging 947 round trips, of which 842 are for business or other necessity purposes. The car has widened his range of service, increased his number of calls, and permitted more patients to reach his office during a working day.

The commercial traveler uses his car most of all. Against the national average of 8,139, the salesman piles up an annual mileage of 18,791. Eighty-one out of every hundred miles is for business or necessity. Using the car and the highway, this man covers his territory more completely than he ever could by train. There was a time when most villages of 1500, or smaller, had a hotel. The commercial traveler supported it. Today, traveling by car, this man can call on his village clients and drive on to the next larger town for the night. Village inns have been passing out of existence. The county-seat hotel and the tourist home have taken away their business.

The accompanying table summarizes the story of how people have incorporated the private car into the web of their economic lives.

Transformation in The Car and the War

On February 10, 1942, we had to stop the production of automobiles entirely in order to devote ourselves one hundred per cent to making the tools of war.

That was when we, the people, had to ask ourselves how vital to victory were our twenty-nine million passenger cars.

We didn't dare to guess.

We had to find out.

Our Washington experts went to work. The first startling fact they discovered was that no less than 13 million people now living in suburbs are out of reach of any kind of transit system—out of reach of railroad, street car, and bus. If these people were to work at war jobs, they would have to travel at least part of the way to their jobs in automobiles. Either that, or they'd have to move closer to their offices and factories. It didn't make sense to try to rehouse 13 million people. The only thing to do was to keep their automobiles running.

Then the experts asked themselves how many workers actually used automobiles to drive to the factory. The facts were striking. An early Michigan survey showed that of 850,000 workers employed in Michigan industry, 635,000 were dependent on cars to get to work.

70% Drive to Work

In the Los Angeles area, where big new war plants were already in operation, more than 70 per cent of the workers drove to work, some traveling as much as thirty miles daily. At one immense California plant, 92 per cent of the 50,000 employes use cars.

A later study was made of 191 war plants in 14 states employing 590,000 people. This survey showed that 68.9 per cent of the workers used cars. In one Kansas plant employing 10,500, no less than 93 per cent of the workers used automobiles.

The freedom given us by the automobile had permitted us to live anywhere, miles from our jobs. It had permitted plants to be built anywhere, far from street car and inter-urban lines. The lesson was plain. If we wanted to win the war we had to keep the cars rolling.

The lesson was just as plain in the country. The farmer has no way to get around except by automobile or pickup, and fewer farmers own pickups than own passenger cars. One expert puts it this way: "The pattern of rural activity is

Cars Are a Necessity

Occupation	Annual Average Mileage per Car	*Necessity Mileage Percent of Total	Necessity Trips Percent of Total
Commercial Travelers	18,791	80.9	86.5
Physicians	12,932	66.8	89.0
Legal Profession	12,898	61.6	77.4
Insurance-Real Estate Salesmen	12,618	71.8	85.8
Salesmen (Unclassified)	12,303	66.6	81.5
Workers	7,657	49.4	72.3
Farmers	5,750	66.8	78.3
All Other Occupations	8,650	50.7	76.6
Average Mileage, All Groups	8,139	50.7	76.6

*By "necessity mileage" is meant not only mileage for purely business purposes, but for shopping, seeing the doctor, and taking children to school.

Press Assn. Inc. Photo

The pretzel, the biggest of highway crossover points in the New York area, is a part of the Long Island highway system at Kew Gardens and represents the trend in road design

based on the automobile. Without it, food production will break down."

Or, to put it in a specific sequence: "The farmer uses his car to fetch a repair part to keep his tractor going so he can harvest his wheat crop so people can eat so we can win the war." It's as plain as that.

Out of these discoveries came gasoline rationing and a speed limit of 35 miles per hour. These restrictions would help to save both tires and the cars themselves.

By carefully studying the situation, experts concluded that most of our 29 million automobiles would have to be kept in operation. If we lost a few million through age and wrecks, we could still keep the nation at work. Under no circumstances would we dare let the number fall below 20 million.

We did pretty well. Car registrations fell from 29½ million on December 31, 1941, to 25½ million on December 31, 1944. Only four million were lost to us.

It was our dealers and service station operators who kept the cars rolling. Eight out of ten dealers stayed in business through the war. They gave up selling cars. They went to work saving cars. As a nation, we were thankful for our nationwide dealer-and-service system.

The war taught us a great lesson.

It taught us how deeply you and I and John and Mary and Pete had incorporated car driving into our personal workaday lives.

Highways Keep Pace

American people could hardly have used their cars as they wanted to if we hadn't done something about the mud.

Back in 1919 we had three million miles of rural highways, just as we have now, but nearly all of it was dirt road. When it rained, the roads turned to soup, and automobile travel stopped in its tracks.

Up to this time, not much was done about roads. Nearly all our roads were under the control of township and county governments. They did what they could to make roads passable, but with the small amount of money they had, they couldn't do much. Money was raised by the property tax. A man could either pay his road tax in money, or work out the tax on the highway. It isn't surprising that under such a system, little was done to create a satisfactory system of highways.

What the motorist wanted was the freedom to go from town to town. The main centers of population needed to be connected up. Somebody had to decide which centers to connect first. It took more than a county government to make decisions like that.

In response to the demands of our car-driving parents, the Federal Government in 1916 provided cash aid for rural post roads, and by 1919, under the urging of the government all states had state highway departments.

Then the government invited the state highway departments to lay out a state system of roads consisting of not more than 7 per cent of the total rural roads of the state. On this system, the government would match the state, dollar for dollar. Additional, and unexpected help came in 1919 in the form of 27,983 surplus motor vehicles, mostly trucks, which, built for the War Department, were distributed to the states for road-building work at the end of the war.

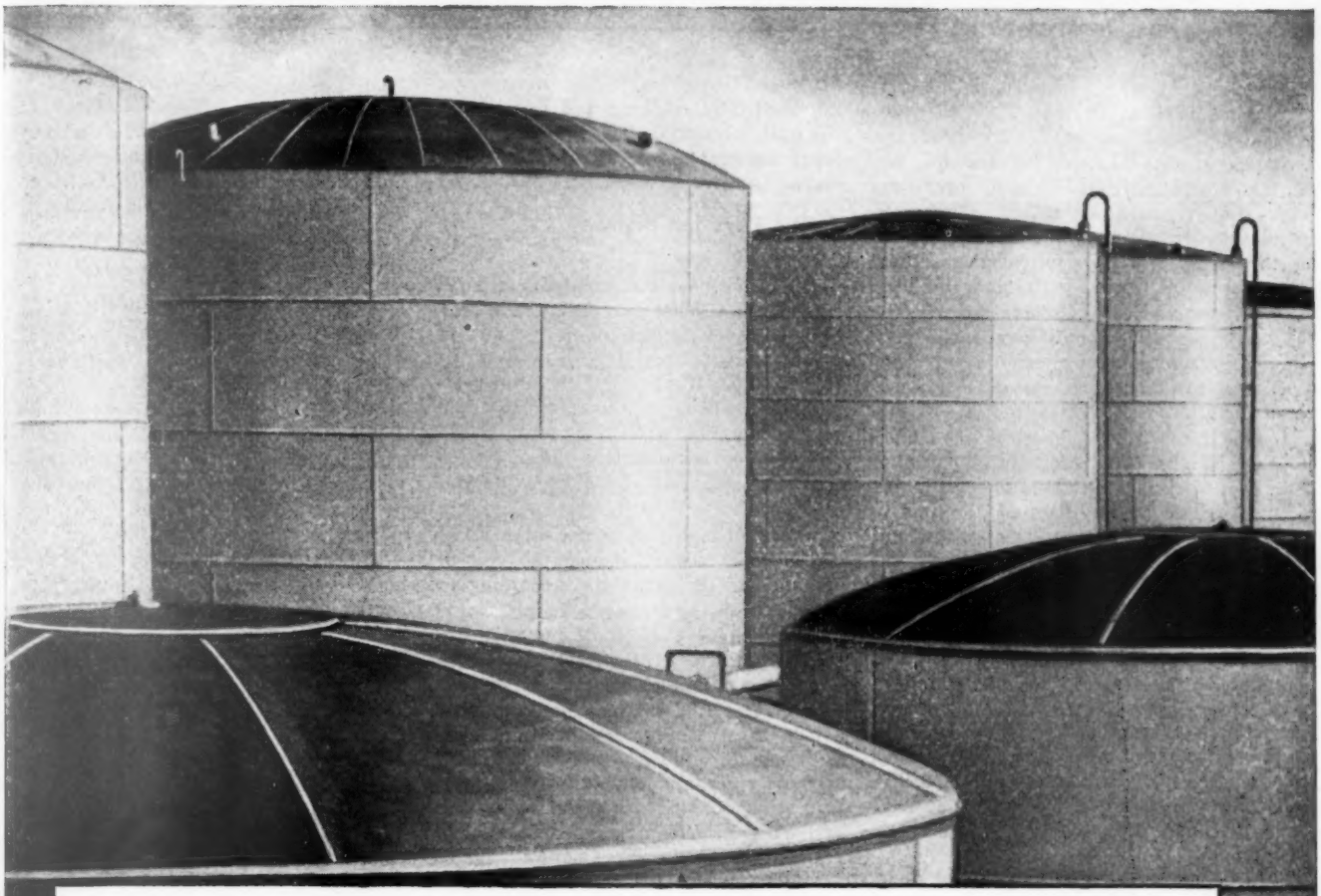
In the beginning, the state highway systems of the country totaled 202,915 miles. Each year the mileage was increased, until in 1940 state systems totaled 329,472, most of which is eligible for federal aid on the dollar-for-dollar basis.

With this kind of central guidance and planning, we could go ahead and do our first job, which was to connect up our principal cities with all-weather roads. Under centralized planning local roads were connected into state webs, and the state systems in turn linked themselves into a national network. Meanwhile technical schools and highway departments experimented with concrete, macadam, gravel, and other surfaces and learned the best way to build them. With a will, the United States went to work building roads.

We made steady progress in surfacing our state systems. During the years covered by this report we paved about 220,000 miles. This enabled us to go freely between major cities anywhere in the United States.

We had taken our first great step.

As road-surfacing went on at an average rate of 26,000 miles a year, the method of paying the cost underwent considerable transformation. In 1920, bond issues based on property provided most of the revenue. With each passing year, however, money collected from the user of the highway became more important. First of all states charged car owners a license fee. The next thing our state governments did, was to put a tax on



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6. **NO CONTAMINATION.** Separate pumps, lines, storage zones for dissimilar commodities.

A Division of General American Transportation Corporation

gasoline. Oregon established the first gas tax in 1919, and by 1929 all states had followed her lead. By 1938 the average state-imposed tax for the nation, exclusive of federal tax, was around 4 cents per gallon. Today, in addition to license fees and gas tax, the motor user pays miscellaneous taxes on tires, oil, repair parts, and the like. All these we now call "user taxes."

We car drivers now pay out a very considerable hunk of money in user taxes. Gas taxes and registration fees have grown from $128,000,000 in 1921 to $1,458,000,000 in 1941. Part of this money goes to the state highway department and is the principal source of revenue for road construction. Part of the money goes to localities for local roads and streets. Part is diverted from roads and streets entirely and is used for other purposes. In addition to state gasoline taxes and registration fees the highway user pays municipal and county taxes, federal excise taxes, personal property taxes on his car (in a majority of states), and tolls for ferries, bridges, and certain roads. These miscellaneous revenues amounted to the substantial sum of $692,000,000 in 1941. Thus the total paid by the highway user in that year was $2,150,000,000.

Prior to the war the nation spent about two billions on its state highways, local roads and streets. We car drivers bear the burden of building and maintaining our state highways. The property owner bears the brunt of local road and street costs.

Traffic Pays for Highway Growth

Highways cost the taxpayers a large annual bill. What is not generally realized, however, is that highway improvements tend to pay for themselves by creating new traffic—and therefore new gasoline revenues. According to highway economists, when a highway is improved, not uncommonly the increased traffic is sufficient to pay for the improvement.

Improved highways confer other financial benefits. They reduce the cost of operation to the motorist. According to a 1928 study by Professor Ralph Moyer at Iowa State College, a motorist can run his car on a high-type surface for two cents per mile less than on a low-type surface. A 1939 study shows that a man can drive for ½-cent a mile less on concrete than gravel. Rural mail carriers, according to an Iowa State College study, driving 15,000 miles a year, save $180 a year on pavement as against gravel. Highways save money.

Highways also create wealth. When a pavement is laid down stores are attracted to it. Buildings and land bordering the pavement increase in value. Out in the country, farm lands rise wherever highways are paved. Many economists believe that this increase in value goes far to offset the cost of the roads.

Good highways, in other words, are considered good business.

Next Job: Out of the Muddle

Now that we're pretty well out of the mud, we're beginning to work on our next job.

Part of this job may be the building of great super-highways like the Pennsylvania Turnpike, between Harrisburg and Pittsburgh. This double highway, with no grade crossings, makes short work of a trip across Pennsylvania.

But most of our job won't be on superhighways. It will be road improvement geared to our most pressing needs. Highways cost a lot of money—around $50,000 for a mile of concrete and we haven't any to waste building roads where they're not most needed. First things must come first.

To find out where roads were most needed, our Public Roads Administration in co-operation with state highway departments undertook in 1936 the most complete traffic survey ever attempted. This survey told us a lot of things that our own comon sense told us must be true. The check was made by simply stopping motorists and asking them where they were coming from and where they were going.

One thing we discovered was that while most of us take one or two long trips a year, practically all our trips are short ones. Two-thirds of our trips beyond the city limits, in fact, are under ten miles, one way. Over 90 per cent are less than 30 miles, one way.

This little fact tells us that maybe there's a more important job to be done than building great transcontinental superhighways.

Another fact the survey discovered was that traffic bottlenecks occur when we get near to the large centers of population. In the country we sail right along. When we get into town we slow down and crawl.

This little fact shows that one of our pressing highway jobs is to get motorists quickly and easily into the hearts of cities and out again. On most of our trips, we don't want to bypass cities. We want to get into them.

Another useful bit of information brought out was which roads were most used. The survey found that some 40,000 miles—1.3 per cent of our total rural mileage—carried 20 per cent of the traffic. These 40,000 miles connect and approach our large centers of population. All this we could have figured out for ourselves if we had sat down and thought about it a while. It's simple, obvious logic.

From these facts, our Public Roads Ad-

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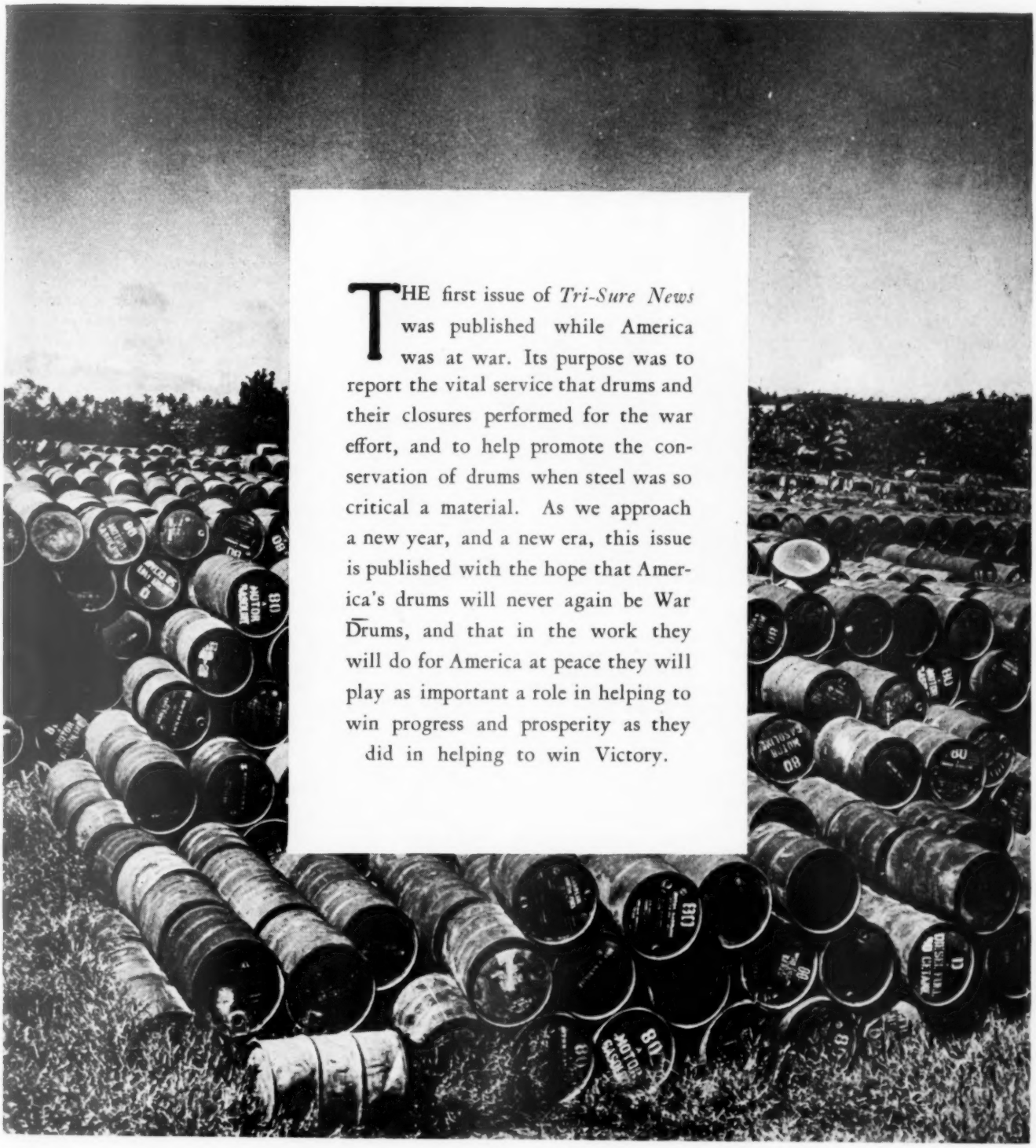
WOOD RIVER OIL AND REFINING COMPANY, INC.

Tri-Sure News

NUMBER 36 ★ 30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK ★ DECEMBER, 1945



THE first issue of *Tri-Sure News* was published while America was at war. Its purpose was to report the vital service that drums and their closures performed for the war effort, and to help promote the conservation of drums when steel was so critical a material. As we approach a new year, and a new era, this issue is published with the hope that America's drums will never again be War Drums, and that in the work they will do for America at peace they will play as important a role in helping to win progress and prosperity as they did in helping to win Victory.

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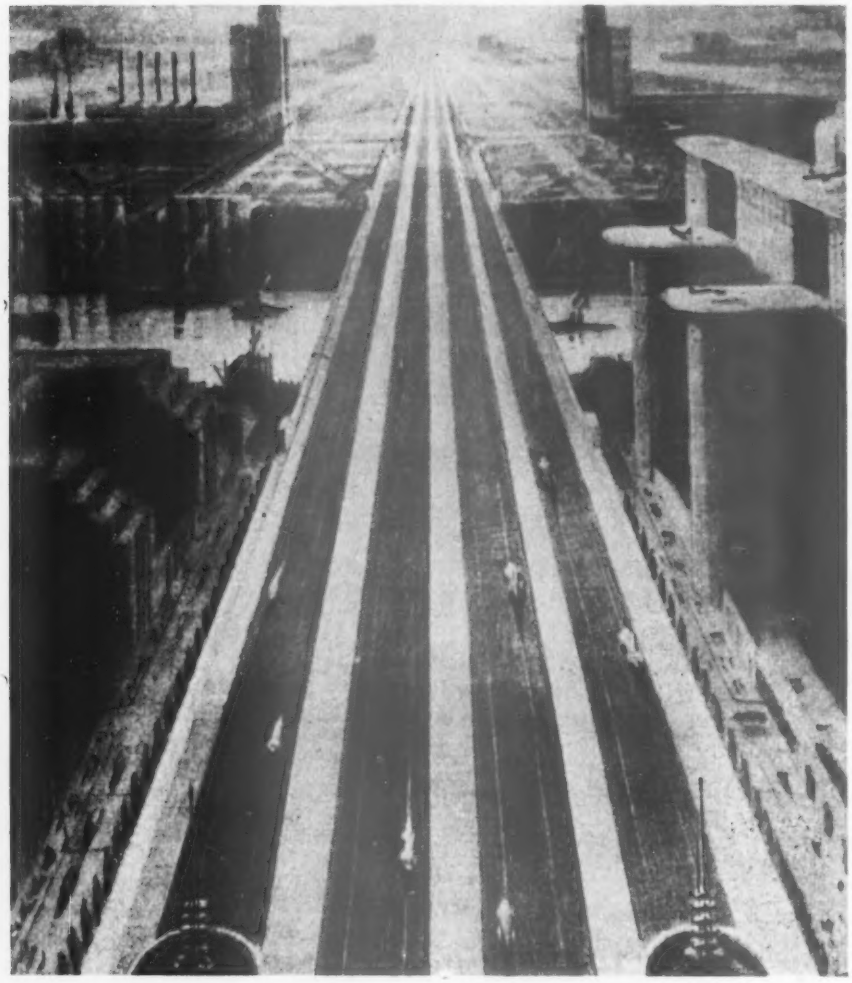
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA



Acme Photo

Following intensive study, engineers have developed a resilient non-skid asphalt surfacing for roads that will permit vibrationless 100-mile per hour auto speeds in perfect safety. L. Andrew Reinhard and Henry Hofmeister, associate architects of Rockefeller City collaborating with Hugh Ferriss, artist, depict above this transcontinental highway as it would appear between New York and Boston. The architects would have the highways go beneath large cities

ministration and highway departments have evolved a master plan recommending what are called inter-regional highways.

These are, for the most part, the 40,000 miles bearing such a heavy load of traffic. The roads already exist. But they need to have curves widened, grade separations provided, concrete strips added. By-passing roads will be added where needed. Express-ways on the order of the Henry Hudson Parkway and West Side Highway in New York will take the motorist from these inter-regional highways right into the city. Improvement along these lines will free motorists traveling between—and into—our main centers of population.

After this principal job, other jobs will follow in order. We'll improve curves and road design on the rest of our rural system. We'll develop our main city thoroughfares. We'll improve less important rural roads as traffic counts show the need.

When our total car registration in the United States reaches forty million, as it soon will, we'll sadly need all this highway improvement. The question is whether it will come in time.

We Find New Kinds of Recreation

The automobile has changed our vacation and weekend habits about as much as it has transformed the pattern of rural and city life. Even before 1919 the touring vacation was born. We became nomads on rubber tires.

In 1919, a long tour was a hazardous adventure. Highway signs were few, and most of us traveled by the Blue Book, which told us to ride out of Hicksville on Main Street, go 4.6 miles, turn right at the Baptist Church, continue 3.1 miles to the grain elevator, and turn left. Roads were bad, and an average of twenty-five miles an hour was good. Two hundred miles in a day was more than fair. If we had motor trouble we were lucky to get service.

People who were hardy enough to take transcontinental tours in 1919 generally allowed themselves thirty days for the trip, one way, and carried along such accessories as chains, tow rope, and a shovel.

These were the pioneers, the motorized Daniel Boones. Mostly, our long-distance tourists shipped their cars to the Pacific by rail, while Eastern owners who wintered in Florida sent their automobiles south on coastwise steamers.

Those of us with less money to spend were pouring out onto the highways with tents, stoves, and luggage piled high in the back seat or loaded into two-wheel trailers.

These early tourists formed organizations for mutual help and advice. One such organization called itself the Tin Can Tourist's Association, and the identifying mark was a tin can perched on the radiator cap. Meeting each other on the highway, members would stop, pass the time of day, and exchange advice on likely camping spots.

Something had to be done to accommodate the flood of motor campers, and at first towns set aside camping areas. Then a few enterprising farmers began to build cabins, and before long tourist courts blossomed out. In 1922, according to the American Automobile Assn., there were some 600 tourist courts. By 1940, we had in this country 13,521 courts and camps doing an annual business of $37,000,000. Along with courts and camps, tourist homes came into existence to serve the traveler. Before the war, an estimated 50,000 homes rented rooms to tourists.

Our new habit of taking tours had its effect on older institutions. Hotels suffered. Resorts that used to book vacationers for two weeks or a whole summer, found themselves transient hotels, entertaining guests for a night. Many went out of business altogether. Certain railroads serving vacation spots lost eighty per cent of their business to the automobile.

With tourist courts increasing by the year, roads getting better all the time, and gas stations springing into being wherever they were needed, we began as a people to discover our continent for the first time.

We Tour the National Parks

Only 128,000 cars entered our national parks in 1920. Year by year the number grew until it hit two million cars in 1940. Of the seventeen million people who visited national parks and monuments in that year, most of them went by car. It isn't too much to say that the automobile gave the mass of people their first chance to see the tall plume of Old Faithful, the spires of Bryce Canyon, and the tumbled ridge of the

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Rockies. The car made the natural wonders of our nation the property of many, not just a privileged few.

The car gave us a chance to get acquainted with our neighbors, too. The way tourist travel to Canada has increased proves it. It was 128,696 cars in 1921. It was over four million in 1939. That's on two-day to thirty-day permits, not just daylight trips to a border city.

We See Mexico

Mexico, too. Through one port, Laredo, the entry of cars has increased from 6,362 automobiles in 1937 to 27,648 in 1939. Travel to Mexico by the new All-American Highway to Mexico City was just getting a good start when war intervened.

Yes, we're getting around and seeing our neighbors, and when the Alaskan Highway to the north is open to the general public, a lot of us will go all the way to Eskimo country at Nome, where you can almost look across the water and see Asia.

We See Our Own Lakes

More important even than these ambitious trips to national parks and neighboring countries is the freedom the automobile has given us to visit the vacation spots near home.

Most vacation goals are within a day's touring time of home. For example Michigan's famous lakes and streams are the goal of many people. Yet, of 2,500,000 outstate cars visiting Michigan in a recent year, four out of every five were from the neighboring states of Ohio, Indiana, Illinois and Wisconsin.

Even California drew more than half of its out-state traffic, in that same year, from nearby Pacific Coast and Mountain states. In Florida, 66 out of 100 outstate cars came from the neighboring Southern states east of the Mississippi.

Few of us can afford transcontinental trips every year. Most of us seek a resort within a radius of 500 miles. But within this 500 miles the automobile has given us freedom of selection. Resorts have departed from the railroad and located themselves at the trail-head. Resorts can now be anywhere there's a road.

State Park

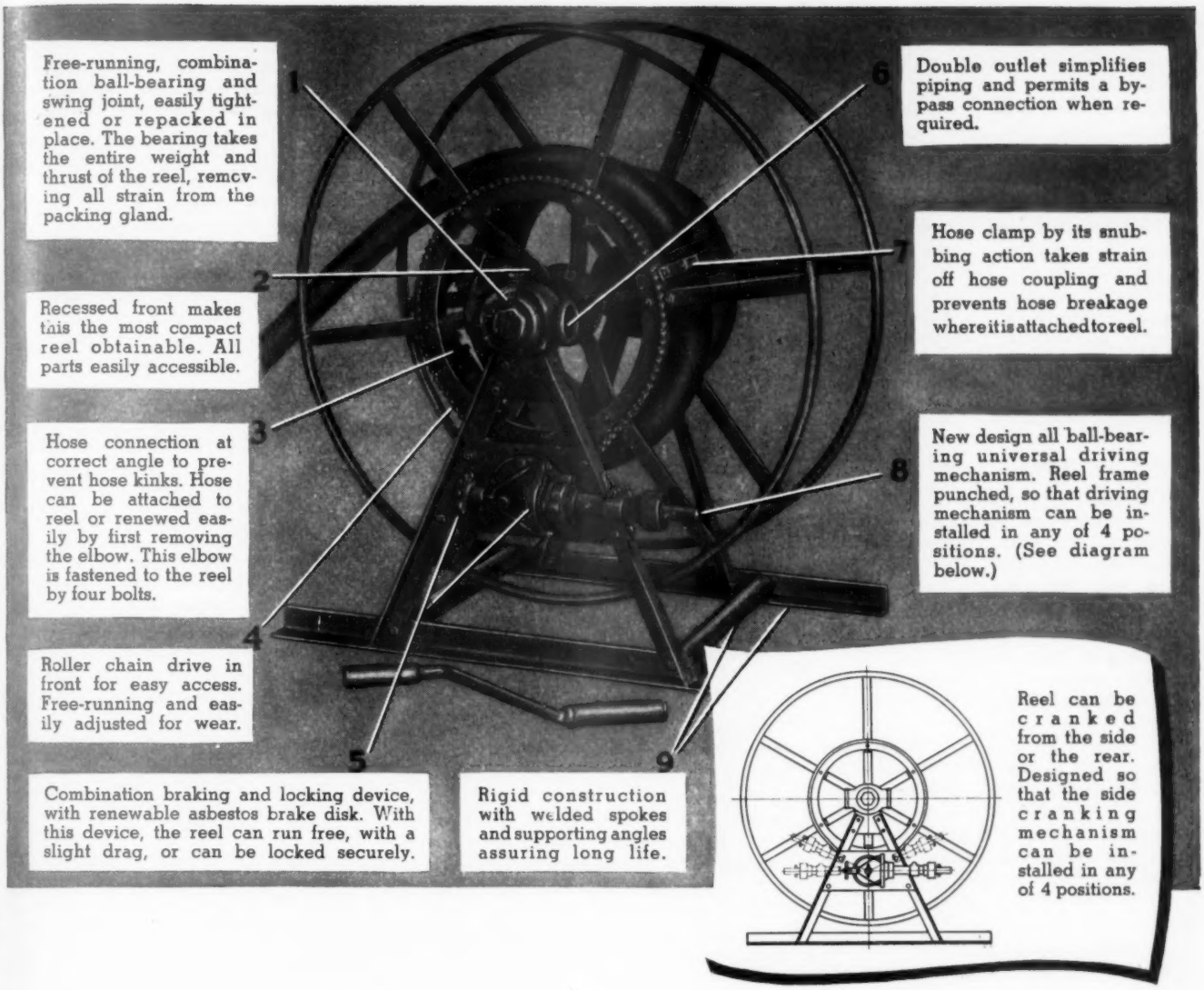
One way many of us find recreation these days is to make weekend trips to state parks. State parks, in fact, owe their existence to the automobile. Before cars took to the highways in great numbers there were hardly any state parks in the country.

Massachusetts, for example, had only one state park in 1920, and seven in 1942. Before the war, about a million and one-half people visited these parks. When gas rationing came, the parks were almost deserted.

California began its park system in 1927 and now has seventy-six historical monuments and scenic areas. Virginia

Acme Photo

These myriad automobiles parked at the New York World's Fair just before the war, eloquently bespeak the highest standard of living in the world, an example of an industrial system that hasn't been approached by any other nation


1
Free-running, combination ball-bearing and swing joint, easily tightened or repacked in place. The bearing takes the entire weight and thrust of the reel, removing all strain from the packing gland.
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Recessed front makes this the most compact reel obtainable. All parts easily accessible.
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Hose connection at correct angle to prevent hose kinks. Hose can be attached to reel or renewed easily by first removing the elbow. This elbow is fastened to the reel by four bolts.
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Combination braking and locking device, with renewable asbestos brake disk. With this device, the reel can run free, with a slight drag, or can be locked securely.
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7
Hose clamp by its snubbing action takes strain off hose coupling and prevents hose breakage where it is attached to reel.
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9
Rigid construction with welded spokes and supporting angles assuring long life.
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The reel can be changed from top winding to bottom winding by reversing the hose connection and rotating the drum. All working parts and hose connections are in front and easily accessible. It is light in weight, a reel that holds 100 feet of 1½" hose, weighs only 93 pounds.

We can furnish hose reels in any size or shape. They can be furnished for installation either in bucket box at rear of truck or in underslung box on side of truck. Give inside dimensions of box when writing for information. Special reels can also be furnished for Airfield Refueling Pits and Ship Docks.

Delivery can generally be made in a few days after receipt of order. For sizes, prices, and dimensions, write for Catalogue No. 165.

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now has six state parks, all opened in 1936. Missouri's park system began in 1925 and now there are twenty.

Some states have gone even farther. They have not only built state parks but are trying to make their main rural highways one continuous park.

Michigan is a leader in this development. Beginning with weed control and progressing to the laying of sod and planting of shrubs, Michigan has placed picnic tables, stoves, and water fountains at intervals along the highway, encouraging travelers to eat picnics under a tree. At points of natural beauty, miniature parks with graveled drives are to be found.

Open Air Shops

Our American habit of rambling over the highways on weekends has converted the borders of our concrete lanes into continuous shops. Here, at a crossroads, you find a farmer's wife tending her roadside market, offering for sale melons, sweet corn, fresh vegetables, strawberries, eggs, poultry and cider.

Drive along a little farther and you see a display of vases, urns, and sundials.

Coast another mile or two and you come upon a small shed bearing the sign "Fishworms, night crawlers, bait." Here the weekend anglers stop on their way to their favorite bit of water.

Farther down the highway, countless weather vanes, carved in the shape of roosters and ships, are stuck in the ground.

As you approach population centers, more pretentious highway shops appear. Here is a drive-in ice cream store, with waitresses to serve you in your car. Beyond is an eat shop, surrounded by a parking lot.

As you approach a golf course, an enterprising salesman offers you linen hats with transparent visors at a dollar a throw. Everywhere over the land ambitious salesmen are displaying their wares along the edges of the concrete to lure your dollar.

And Golf

We mentioned golf. When you get down to it, golf owes its widespread popularity to the fact that everybody drives a car. It's no accident that the number of golf courses multiplied as car ownership increased. There were only two hundred golf courses in the United States in 1914. Now there are something over 5,000.

Between golf and nearby beaches and lakes, state parks, and national parks and monuments, the American public, with a family car and a moderate budget, has a wealth of riches on which to draw for weekend and vacation entertainment. This very freedom of selection has made people reluctant to settle on one spot, buy a summer cottage, and return there year after year.

Travel has become a big business. The American Automobile Assn. estimates from Census Bureau figures for 1937 that motor touring is a five billion dollar business, in which 52 million people in 15 mililon cars spend one billion for gas, oil, garaging and repairs; another billion for lodging, one and one-quarter billions for camping supplies and souvenirs; a billion for meals and the remaining small change of $700,000,000 on golf courses, pop and hot dogs.

Travel on this scale is something new on the face of the earth, and what it means in the breaking down of sectionalism, appreciation of our country, and breadth of personal viewpoint our psychologists will have to decide. All we can say is that it has happened.

We Keep Cars Running

To maintain the kind of travel we've been talking about, there has developed a nation-wide service organization unprecedented in history. The business of servicing cars has not only expanded, it has been simplified with the passing years.

In the 1920s, there was a lot of machine work in connection with car repair. Pistons had to be replaced. Cylinders had to be rebored, ground and honed. Valves needed frequent refacing. Taking apart and reassembling engines was a regular practice.

Today, machine work has been greatly reduced. Service today consists chiefly of taking out a worn unit and replacing it with a new one. The old oil filter comes out and a new one goes in. A faulty or worn carburetor is replaced complete. A worn clutch comes out and a new one takes its place. The modern service man is aided by electrical devices to analyze trouble, improved tools to straighten frames, bump out bodies and fenders, and align wheels.

This kind of service, highly standardized and requiring considerably less shop time, has resulted in the spreading of service to thousands of new establishments. The car owner can get service now, not only from the larger dealers, but from independent garages and even filling stations. According to the 1940 Census, automobile parts, accessories and service were available at the following:

Franchise Dealers	33,609
Independent Repair Shops	66,178
Accessory, Tire and Battery Shops	18,525
Filling Stations	241,858

This is a total of 360,170 establishments, doing a business of $8.5 billions a year, to accommodate the motorist. It has been a necessary development in a nation owning almost 30 million passenger cars.

The kind of nation-wide service afforded by the automobile industry has taught other industries how to give service. A country doctor in the South, 25 years ago, bought considerable electrical equipment for his office, but after a short time sold it all and reverted to older and more trustworthy methods, because the nearest place he could get batteries charged was Atlanta, many miles distant. Today, battery service is offered in every hamlet.

Following the automotive cue, the makers of refrigerators, ranges, vacuum cleaners, furnaces and even electric razors, have set up service establishments in strategic cities throughout the country.

The automobile industry has set the national pattern for service.

Highway Accidents

Not all chapters of the car and highway story make equally good reading. The record of motor-vehicle deaths on our streets and highways, rising gradually to some 40,000 in 1941 is one of the unnecessary prices this nation has paid for the privilege of going where we please when we please.

The car-driving public has never shown as much concern as is desirable over the traffic toll. In spite of public indifference, however, the various agencies interested in safe driving have cooperated to discover the way to reduce accidents and have succeeded in stemming the tide. From a high of 18.4 fatalities per 100,000,000 vehicle miles in 1934, the nation has come down to a rate of 12.7 in 1941. The total number of accidents during that period increased, but miles traveled increased much more. The accident rate per miles traveled has come down.

There has been no single answer. Part of it is in highway engineering—rebuilding curves, removing obstacles to range of sight, dividing highways where traffic is heavy, and improving warning signs and markings.

Part of the answer has been the creation of proper skills and attitudes through education of the driver.

Another part has been in the right kind of law enforcement. Police have learned to study traffic violations and punish most severely the types that cause accidents. They have learned to analyze an accident on the spot, trace it back to its causes, and take steps to remove the causes. In 28 cities where this kind of "selective enforcement" has been conscientiously practiced an accident decrease of 46.6 per cent—far better than the national average—has taken place.

Part of the answer has been in the writing of proper laws on minimum age, driver qualifications, periodic re-examination, and so on.

Out of all these measures the Automotive Safety Foundation has worked out the Standard Highway Safety Program combining the seven points of legislation, motor vehicle administration, engineering, enforcement, education, personnel training and research.

This program, which combines the known and proven techniques of acci-

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IN ONE SENSE . . . time and calendars have lost their despotic power over the petroleum industry.

Only yesterday the industry annihilated time . . . compressing the technological developments of a pair of decades into months so that the march to victory could be powered with a torrent of high-octane fuels and lubricated with oils equally indifferent to desert sun or arctic cold.

Today, the postwar refinery is more than a set of blueprints locked away in the company safe. Those blueprints are out on the boards . . . being altered to meet competitive conditions of the current market. In many cases, the girders and towers for new installations are already going up.

And tomorrow?

It's no secret that Kellogg process and development engineers are well along with their work on new processes. These projects have merely generic names at the moment . . . natural gas synthesis . . . desulphurization . . . hydrogenation. But they envision the possibilities of a decrease in crude supply; the necessity for more efficient utilization of poorer grade crudes; the future need for higher quality products at lower operating costs.

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dent prevention, is by no means universal throughout the country. Where its points are understood and followed, the accident rate has gone down.

The conclusion of students of the safety program is that the motor-vehicle accident problem can and will be brought under control just as soon as the standard program becomes general in the United States. It will be a long job, but a sure one.

The Rich and the Poor Ride

At first thought, you'd hardly suspect that a family man with an income of $750 or less per year could devote any money to an automobile.

Nevertheless, he does. A survey made in 1936 shows that out of 5½ million non-relief families in that group, two million spent cash on automobiles! This same survey found that people with cash incomes as low as $250 per year own and operate cars.

In the income group between $750 and $1,500, 5 million out of 9 million people own cars. In the next higher bracket, $1,500 to $3,000, we find a still higher proportion of ownership, 5.7 millions out of 7.7 millions. Above $3,000 nearly all families—2 million out of 2.4 million—own cars.

Plainly enough, in this country, the rich and the poor ride. It is interesting to seek the reasons why this has happened. Let's talk about some of them.

Car Prices Drop

In 1925, the average retail price of all cars was $1,007 (at the factory, including federal taxes and standard equipment.)

By 1940, the average retail price was $778. But this reduction of $229 doesn't represent the actual reduction in cost because the car of 1940 was an entirely different article than the 1925 automobile. The average 1925 car was 32 horsepower whereas the 1940 car was 85. On the basis of horsepower, with all that it means in performance, we were paying $31.50 per horsepower in 1925 and only $9.10 in 1940.

Cars of 1940 were bigger and heavier. On the basis of weight we were paying 43 cents per pound in 1925 and 26 cents in 1940.

Horsepower and weight hardly describe the difference between the two cars. Balloon tires, safety glass, all-steel bodies, improved springing, better painting, windshield wipers, rear vision mirrors and a host of advantages, absent then but standard now, make any comparison of the two products difficult.

Operating Costs Are Less

Along with the reduction in price, better engineering has resulted in a decrease in operating costs. Family records of operating costs are unreliable, but fortunately we have the records of companies owning large fleets of light passenger cars. These show that from an index of 100 in 1926, operating costs have dropped to 50 in 1939. These are the per mile direct costs, fuel, tires, and repairs. Lower operating costs have encouraged people to run cars.

Installment Buying

More important in spreading ownership than reduced first costs and lowered operating costs is the American system of car purchase. When John Doe wants to buy a new car he doesn't have to dig down into his savings account for $778. He turns in his used car and receives credit that amounts roughly to a down payment. For the balance he signs 12 or 18 monthly notes and drives out of the dealer's place with a new automobile.

Time payments began as early as 1912, the buyer paying something over half down and the balance in one or two installments. As time payments became more general, it became customary to require a down payment of one-third and the balance in 12 monthly installments. The exact terms have varied with the times. The net effect of financing and trading-in has been to permit a man to acquire a new car for little or no cash outlay and "painless" payments spread over a period of time. About two-thirds of our buyers finance their car purchases in this way.

Trading-in cars, a practice that "grew up" with the automobile business, provides the owner with an ideal method of liquidating his present investment. If a man wanted to get rid of his present furniture in order to re-equip his house, he'd have to undertake the task of selling his furniture piece by piece, or look up a second-hand dealer and get a price. He could hardly go down to any store and get an "allowance" on his old furniture, to be applied against his new purchase. Yet the automobile dealer provides exactly this service.

The automobile dealer has been in the habit of considering this matter of accepting used cars a "problem." Yet if he didn't offer this convenience he could hardly expect to sell as many cars as he does.

Dealers today not only accept a used car when they sell a new car. When they come to sell the used car, they frequently take an older used car in order to complete the sale. Then they must get rid of this car in turn.

During the period of this report, the marketing of used cars has steadily increased until it has dwarfed in numbers, if not in dollar volume, the new car business. Where, in 1919, dealers sold one used car, or less, for every new car, in 1940 the ratio was two used and one new.

Used Car Is the People's Car

Today the man of limited income can buy a wide variety of cars at prices ranging down to a few dollars. Manufacturers who tried to compete with the used car market by offering a "stripped down" low-cost new car have fared badly. During the depression, attempts to sell "standard" models in competition with "masters" and "de luxes" made little headway. Efforts to sell the European-type small car met with little success. People could get a full-size used car for less money.

The automobile may be compared to a package containing approximately 100,000 miles of transportation. The man of low income can't afford to buy the full package, any more than he can afford to lay in ten tons of coal for winter. He buys whatever part of the package he can afford. If he has enough money he buys the last 60,000 miles. If his cash is extremely limited he may buy only the last 5,000 or 6,000 miles.

There has been little chance in this country of introducing a low-cost people's car, as Germany planned to do in the 1930s. We already have it. The used car is it.

It should be added that universal ownership of "full-size" new and used cars is a phenomenon that occurred under the economic conditions that pre-

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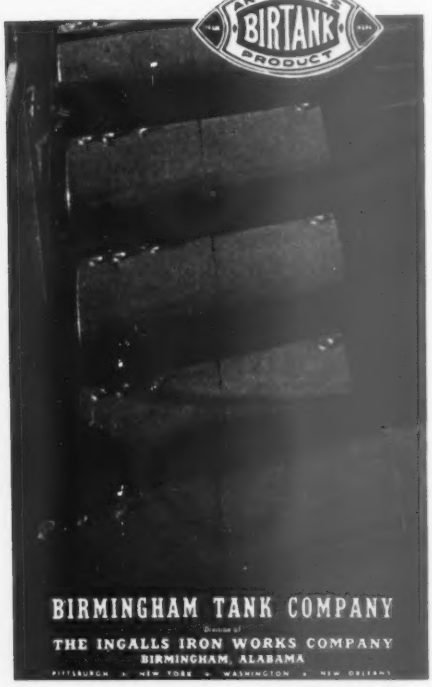

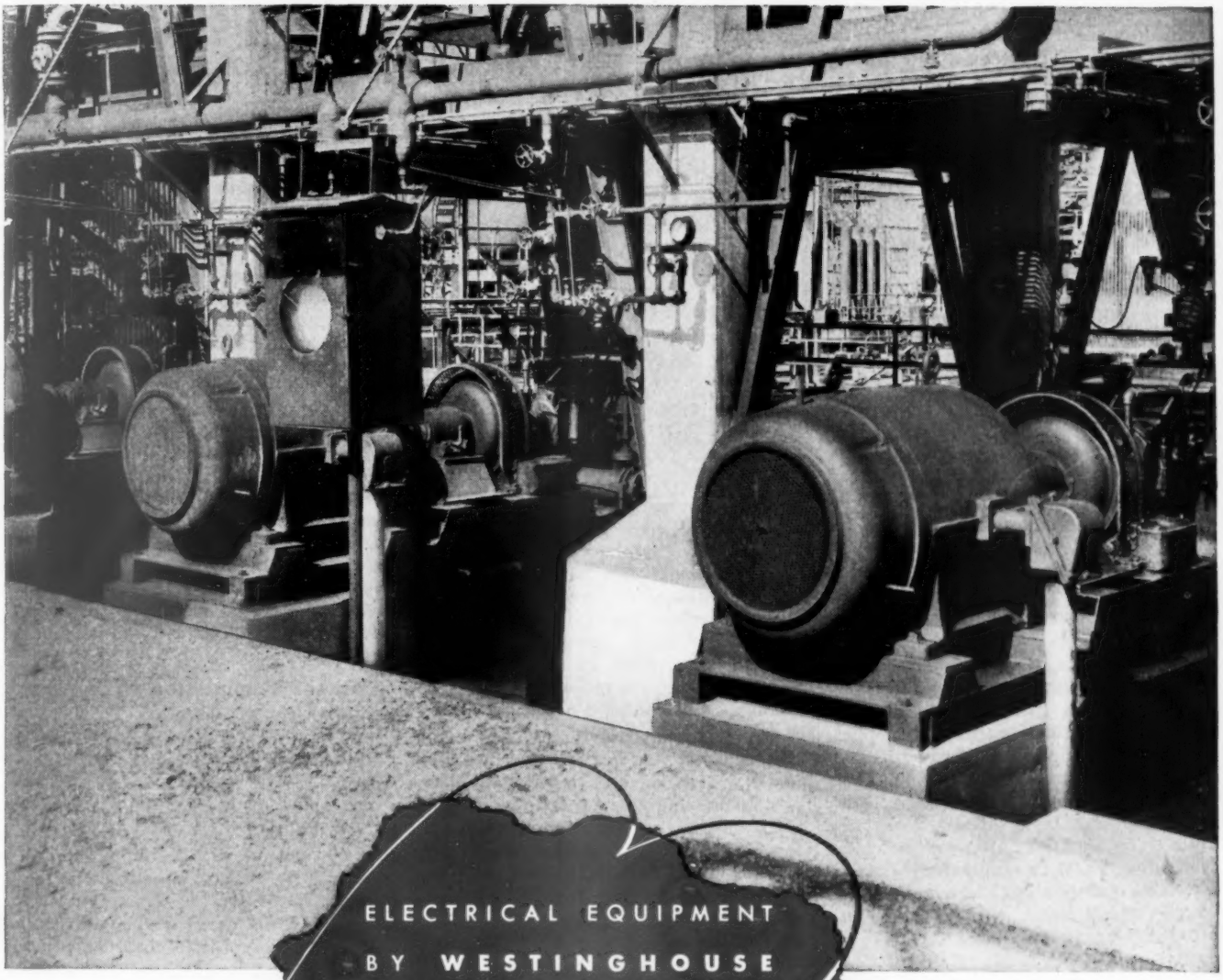

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vailed between the wars. If, after the war, peoples' incomes are radically altered, the capacity of people to own and operate our present-day kind of motor car will be altered as well.

Taxing and Regulatory Policy

A final factor in our mass ownership of cars has been our federal and state taxing and regulatory policies. The American public has been fortunate in that these policies, thus far, while not always equitable, have not been unduly restrictive of car use, car design, or car ownership.

Comparisons of taxes paid by Americans and those paid by Europeans are difficult. In general, Americans have been required to pay less for the privilege of owning and driving a car than Europeans.

Just as important as the fact that our taxes are lower, is the fact that taxes in this country haven't been of a kind that unduly hampered the automobile designer. This hasn't been true in foreign countries.

England's tax, for example, based on horsepower, penalizes the more powerful car and has, therefore, been a strong factor in creating smaller automobiles. Furthermore, England's horsepower tax is figured by an arbitrary formula that has forced British manufacturers to develop smaller bore, longer stroke engines. By contrast, American designers have found that in terms of dependable low-cost operation engines with a shorter stroke and a larger bore are preferable to the other kind.

Men in the industry feel that continuation of non-restrictive tax policy is desirable. They hope that the postwar legislative policy will be to concern itself chiefly with public safety, leaving the designer free to meet the legal requirements in his own way. In this way, too, the full benefit of private and personal transportation are most likely to be realized.

Other Reasons for Mass Ownership

There are other reasons for wide car ownership in the United States. We are blessed, in this country, with an ample supply of low-cost fuel. Wage scales in the United States are far higher than those in other countries. Furthermore, people in the United States have always had confidence in the future, and therefore have been willing to spend their money. The very size of the nation, affording a large market without artificial trade barriers, has been a factor in mass ownership, because the size of the market has permitted large-scale manufacture, and this in turn has permitted the kind of tooling and productive processes that have enabled American manufacturers to make high-value cars at low cost.

Go to a mid-west village, seek out the head of a family earning from $1,000 to $1,250, ask him what he spends for various necessities and you will discover the following figures:

Food	$375
Housing	124
Clothing	97
Automobile	73
Doctor	45

This statement of the importance of the car in relation to other family expense comes from U. S. Department of Agriculture Consumer Purchases Study made in 1935-36. The same study showed the following figures for a family in the $2,500 to $3,000 income bracket:

Food	$571
Automobile	334
Clothing	255
Housing	194
Doctor	121

This is an indication, at least, of the value placed upon personal automobile transportation by the American people. The valuation varies with the locality. In large cities where mass transportation is well developed, a car doesn't rank so high as a necessity. In rural regions and western cities where mass transportation is lacking, the car ranks with housing, clothing, and food as a necessity of life.

Consumer purchase studies show also that families with incomes of $1,000 or under spend somewhat under 6 per cent of it on automotive transportation. Thereafter the percentage rises until we reach the $2,500 to $3,000 bracket, where car expense ranges from 8.2 to 14.4 per cent of the total income. Above $3,000, a decreasing share of the total income goes to the car. If we were to say that the average American family spends $10 out of every $100 on his automobile, we wouldn't be far off.

The wisdom or un-wisdom of devoting this much money to the car is a subject that is beyond the scope of this report. The data are presented as a matter of simple fact. This is what the people have done. It is the way they wanted to spend their money.

Today it is second-nature for all Americans, upon leaving the house, the factory, or the office, to climb in behind the wheel of an automobile. This little act has become the great American habit. The purpose may be only to drive down to the corner drug store. It may be to visit Mexico City or Yellowstone Park.

All these combined errands, multiplied millions of times every day, have changed the nature of our countryside, our cities, and our government, and our pattern of daily life. The United States of today is far different from the United States of 1919. Today, we take for granted that part of our heritage is to possess our own personal means of transport, so that we can come and go, whenever and wherever we please, within the limits of our free time and our pocketbooks. This concept of freedom of transport is the very essense of the revolution which has made the car a vital part of our lives.

Plenty of Oil for Next 100 Decades S. O. Prexy Writes

NPN News Bureau

CLEVELAND — Eugene Holman, president of Standard Oil Co. (N. J.), in an article in the January issue of *The American Magazine* terms as "utter nonsense" predictions that we shall have no more oil in 12 to 14 years.

On the contrary, Mr. Holman says, anyone who imagines that our oil supply will perish in the next decade, or even in the open forum of our public meeting."

The article deals with the potential supply of petroleum throughout the world, discusses petroleum substitutes, 100-octane gasoline and other phases of the oil business in non-technical language.

The author says that on purely business grounds the oil industry has less concern over the failure of the oil supply than over development of atomic power. He adds that by the time we begin running engines on atomic energy, oil will have created a new industry for itself as a source of chemicals and special products.

Compact Commission to Meet In Wichita Dec. 13-15

Special to NPN

TOPEKA, Kans. — Winter quarterly meeting of the Interstate Oil Compact Commission will be held in Wichita Dec. 13-15. William W. Clary, first assistant attorney general of California, and a representative of the Department of the Interior, will discuss the respective views of the states and the federal government as they relate to ownership of submerged coastal lands.

The discussion, an open forum, on the second day of the Compact's program, was described by Gov. Andrew F. Schoeppel of Kansas, commission chairman, as "one of the most important matters now confronting the oil and gas industries."

"The Interstate Oil Compact Commission," Gov. Schoeppel said, "seeks to have presented before it a full picture of both sides of the question. As a voluntary cooperative agency of the people, we desire to hear representatives of opposing sides present their views in the open forum of our public meeting. Ours is an open mind".

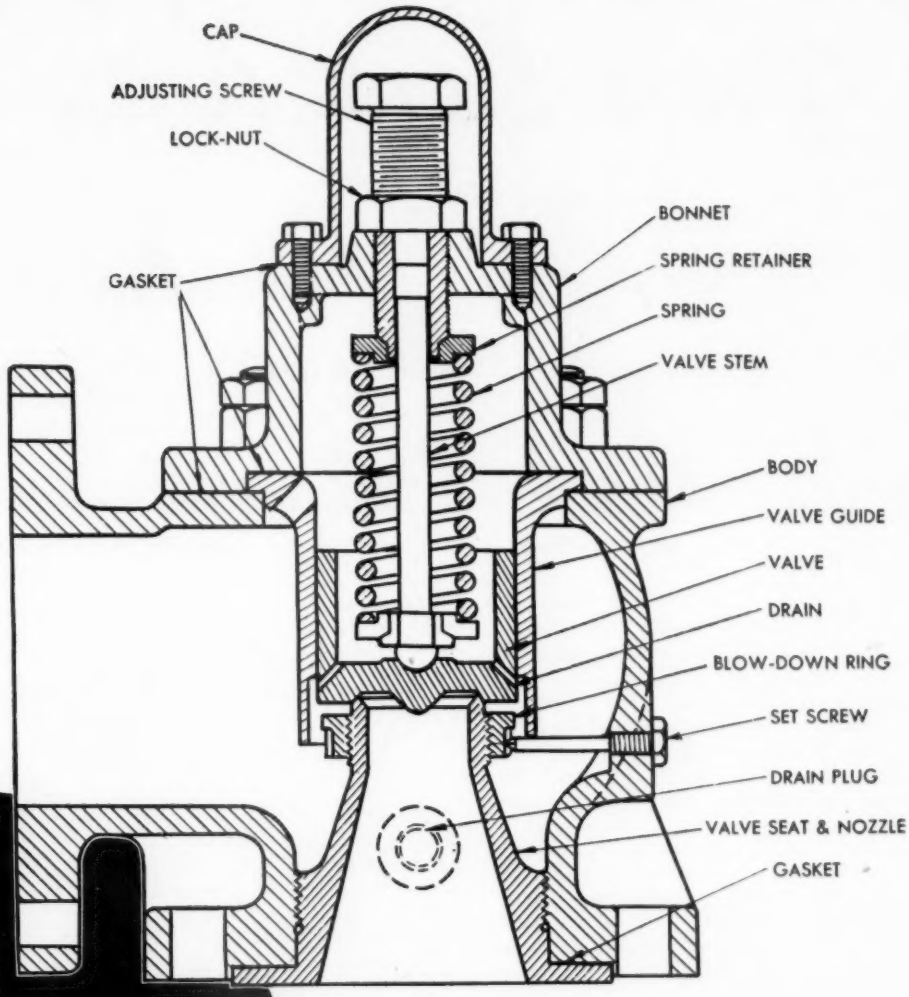
Dominion Government Not Interested in Canol Project

Special to NPN

OTTAWA—The government of the Dominion of Canada has disclosed that it has notified the United States government that it will not exercise its option to purchase the Canol project property.

Under the Canol project agreement, Canada was to have first chance to buy the property at the conclusion of the war.

The Dominion government has been notified by the United States government that it will submit plans for the disposition of the project later.



OCECO V-105 *Pressure Relief Valve*

THE OCECO V-105 Pressure Relief Valve operates as a safety valve for vapors and gases, and as a relief valve for liquids,— and is suited for a wide variety of uses in protecting property and personnel. The valve is of simple, rugged construction. It is designed for smooth, efficient, positive operation — extreme durability — and long, highly satisfactory service.

The beveled seating surface assures positive, consistently tight seating of the valve. The loose threads on the nozzle, and the ample reinforcement on the lower neck, minimize distortion, warping resulting from temperature changes, and other misalignments that might have an unfavorable effect upon proper seating.

High lift and high flow capacity are designed and built permanently into the valve, and the spring is well protected against failures resulting from corrosion.

The nozzle is extra long thus bringing the valve seat well above the lower part of the discharge area. Consequently friction losses are extremely low when discharging vapors,— and — being of top guided construction, the valve does not experience the coking and sticking encountered when valves are guided from below.

Extensive laboratory and field tests have proven that these valves have minimum blow-down. After the blow-down ring has been set in the desired adjustment, it is locked securely in place with a set screw. No change in the capacity of the valve, or the size of the secondary orifice is possible, until the screw is retracted, and the blow-down ring readjusted.

All working parts are easily accessible, simply by removing the cap and bonnet, simplifying inspection and maintenance. Provision is made for gagging, and the valves can be provided with a lifting mechanism if desired.

Furnished with iron or steel bodies, with either bronze or stainless steel trim. 2″ x 3″, 3″ x 4″, 4″ x 6″ and 6″ x 8″ sizes are standard. Other sizes on special order.

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Uncle Sam's Arctic Airline

—Navy photo

Study in contrasts—Naval Air Transport Service plane and a dog sled at Point Barrow, Alaska

By Paul Wollstadt
NPN News Editor

Information for this article was gathered by Paul Wollstadt, NPN's news editor, while he traveled with a group of 16 newspaper and magazine correspondents on a Navy-sponsored air tour of Alaska and the Aleutians. The party traveled 15,000 miles in 13 days in Naval Air Transport Service planes.

Naval Air Transport Service flies literally all over the world, carrying passengers, cargo and mail to and from America's far-flung outposts. With 436 transport planes, 6217 officers and 20,441 enlisted men, NATS has scheduled flights over 52,896 miles. From the time of its formation in March, 1942, until Oct. 1, 1945, NATS carried 371,245,152 ton miles of cargo and mail and 1,358,558 passengers, including 50,000 men evacuated from battle areas to base hospitals.

Part of this vast organization is Squadron VR-5, flying the Alaska-Aleutians route, which became Uncle Sam's Arctic Airline when it was given the job of supplying the Navy's exploratory oil operations on the Arctic slope.

V (meaning heavier than air) R (meaning transport)-5 was commissioned in June, 1943, a year after NATS first made experimental flights into the far north without navigational aids or workable radio communications. Now there are radio range stations, multiple weather reports, hangars, servicing facilities, crew housing (first crews sometimes lived in planes), emergency landing fields and ground-controlled approach systems.

The squadron now flies regularly to Kodiak, Adak, Attu, Fairbanks, Anchorage and Point Barrow, through the treacherous Aleutian winds and in some of the coldest weather on this earth. The route is still a tough one. And despite the difficulties, VR-5 has not had a single serious accident from its inception to the time of this writing.

In January of this year, VR-5 was told to lend a hand to support the Navy's oil exploration in Naval Petroleum Reserve No. 4 on the Arctic slope. This meant flying to Point Barrow, only 1100 miles from the North Pole, and to Umiat, 172 miles southeast of Barrow, where the test well was to be drilled.

On Jan. 20 the first survey flight from Fairbanks to Point Barrow was made. Before the end of February three flights a day became routine. In March service to Umiat was started.

Then came the big test for VR-5. The spring breakup was coming. The Seabee tractor trains (see NPN Nov. 28, pages 30 and 31), designed to operate over ice and snow, no longer could haul supplies from Point Barrow to Umiat. If drilling was to continue, it was up to VR-5 to move materials and men to the well site.

In the month of April VR-5 made 259 flights in and out of Point Barrow, 145 of them to or from Umiat.

The most remarkable of these flights were made between April 17 and April 23, when 5642 feet of drill pipe (182 pipe, each 31 feet long) were moved from Point Barrow to Umiat. The cargo compartment of the R-4-D (Douglas two-motored transport), the type of plane used, is only 24 feet long. The 31-foot lengths of pipe extended into the pilot's cabin. The magnetic attraction threw the compasses off and the pilots, all of them fortunately experienced in Arctic aviation, had to rely upon the scant radio aids in the Arctic Circle, supplemented by their knowledge of the few landmarks.

Here are a few additional facts about VR-5 and the Fairbanks-Point Barrow-Umiat operation:

THREE ENGINE FAILURES are on the pilots' logs, but in each case the plane was brought home safely.

TEMPERATURES lower than 50 below zero were frequent.

A DAMAGED PROPELLER was the worst damage recorded in the Arctic Circle.

1,697,000 POUNDS of passengers, cargo and mail were flown the 517 miles from Fairbanks to Point Barrow between Jan. 20 and Nov. 1. This is more cargo than any other flying organization, with a like number of planes and pilots, has carried over a comparable distance.

1375 DRUMS OF OIL products (75,625 gals.) were flown from Point Barrow to Umiat in the month of April.

10,000 POUNDS OF COAL were carried in two trips.

UNUSUAL CARGO included 10 dogs and two sleds, drillers' mud, 50 boxes of dynamite caps, a 5200-pound generator, a jeep, a weasel, a 4260-pound tractor frame.

Much of this cargo obviously was difficult to unload, but average turn-around time at Umiat was only 11 minutes, a record to which NATS men and Seabees point, saying "Try to top that!"

The accomplishments of VR-5, as to amount of cargo, speed and safety, would have been impossible without competent direction from Seattle, headquarters of the squadron, and from Oakland, headquarters of the entire NATS organization. But it took good pilots as well, and VR-5 has them.

Most VR-5 pilots had long service in Alaska or on airlines flying the northwest area of the States before joining the Navy. For example, Lieut. Earl V. Lee, the pilot on the correspondents' trip, had flown in Alaska for seven years prior to being commissioned. He knows the ter-

Oil Geologist Navigation Officer of NATS Squadron

A petroleum geologist is navigation officer for Squadron VR-5 of Naval Air Transport Service. He is Lieut. Com. Robert C. Lafferty of Charleston, W. Va. Just before the war, he was assistant chief geologist with Libbey-Owens-Ford Glass Co. Earlier he was associated with Columbia Carbon Co. and with Gulf Oil Corp. While in VR-5 he helped in the aerial mapping of Navy Petroleum Reserve No. 4 in which Umiat Test Well No. 1 is located.

Here's how to cut container purchasing *Red tape*

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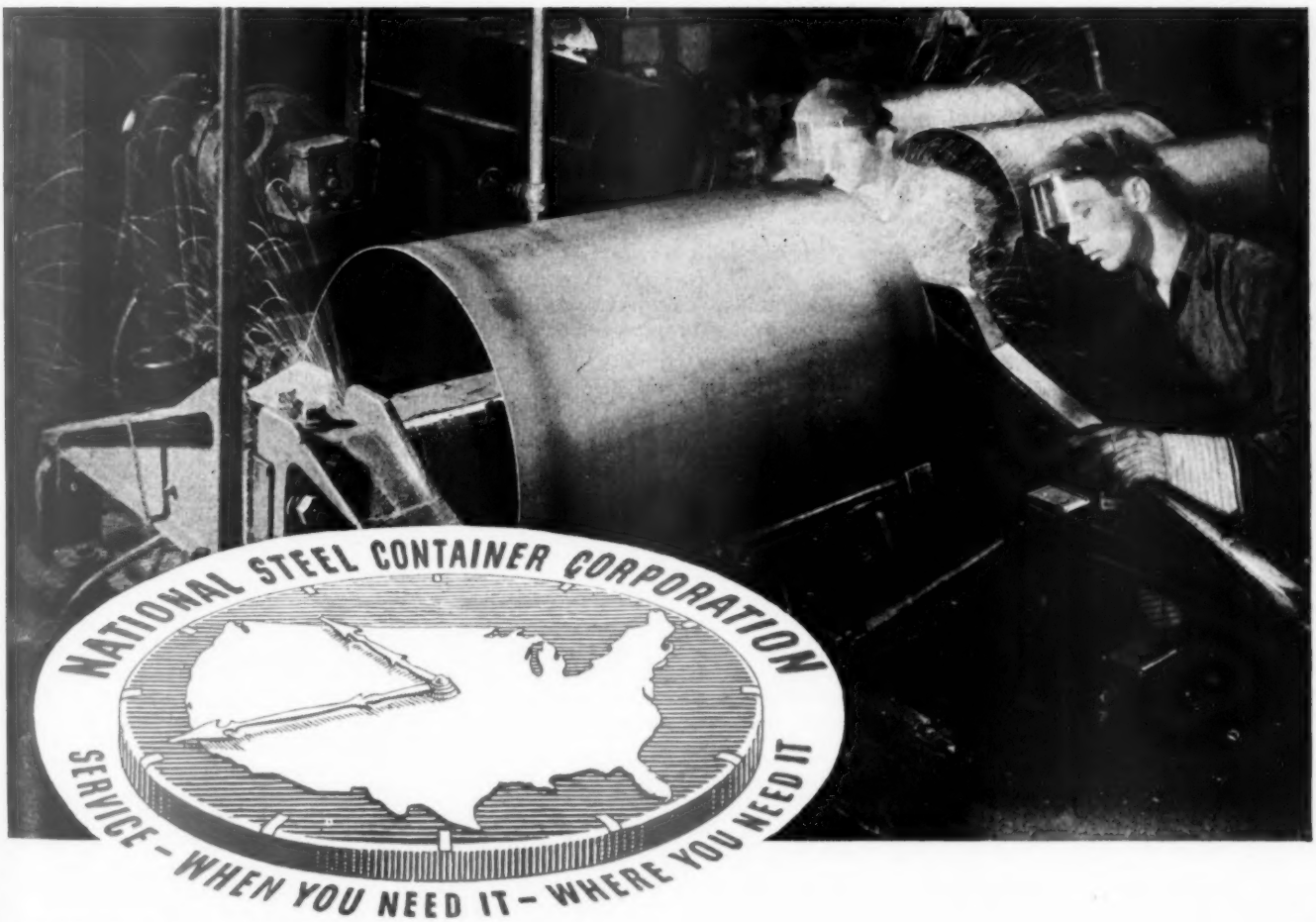
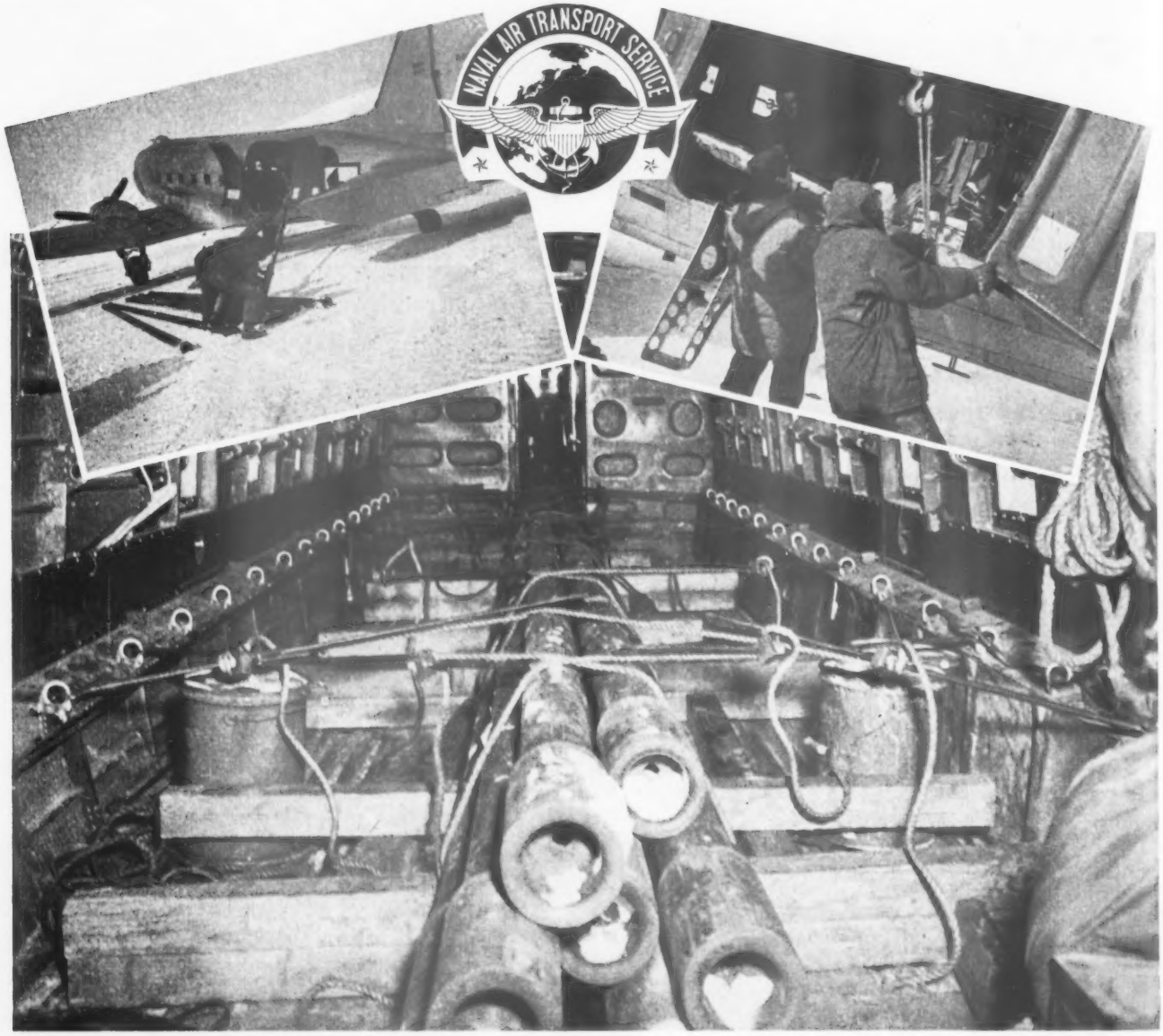


Pipe Too Long for Cargo Compartment but NATS Gets It to Umiat Test Well Site



—Navy photos

Naval Air Transport Service was called upon to move 182 pipe, each 31 feet long, from Point Barrow in Umiat, Alaska, using planes with 24-foot cargo compartments. Upper left: Seabees and NATS men ready to load the pipe. Upper right: Putting the pipe into the plane. Lower: ready to fly; the pipe extends into the pilot's cabin. Inset: The NATS insignia

rain around the cities and villages of Alaska as well as an oil marketer knows the streets of his home town.

Army and Navy operations in Alaska have advanced aviation there at least 10 years. In addition to the major Army and Navy bases at Fairbanks, Adak, Kodiak, Attu and Anchorage, there are several smaller but excellent fields and scores of emergency landing spots. And there are the ground aids. Thanks to the military, aviation has come of age in Alaska.

It is natural that Alaskans, to whom few surface roads are available, should become air-conscious in the midst of the military air activity. But the extent of their airmindedness is a bit startling to a resident of the States. They speak of Anchorage as being three and a half hours, rather than 580 miles, from Juneau. They are intensely interested in new airplane design, in route extensions, in schedule improvement as factors that will affect their everyday lives, not a dozen years from now, but next year, even next week.

If there is an Alaska boom, it will be because the airplane has become a commonplace method of communication. And it is the military (Army and Navy) which has made it so in the far north.

If anything comes of the oil exploration in Navy Reserve No. 4, it will be because aviation—Squadron VR-5 of Naval Air Transport Service in particular—has brought the Arctic slope within hours and days of the States where it used to be months and years away.

Standard (Calif.) Opens Office

NPN News Bureau

SAN FRANCISCO—Standard Oil Co. of California is planning to establish a district office in Fresno about Jan. 1, it was announced by President R. G. Follis.

Geological Society To Hold Annual Meeting in Pittsburgh

Special to NPN

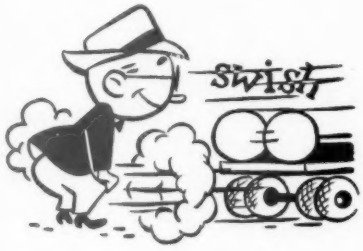
PITTSBURGH, Pa. — The Geological Society of America will hold its 58th annual meeting here Dec. 27, 28, 29 at Hotel William Penn, C. H. Feldmiller, chairman, publicity committee, announces.

The meeting, under the auspices of the Pittsburgh Geological Society, will be on the following topics: Geology in War and Peace; Geology in Engineering; and The Geological Society's Obligations to Geologic Science and Public Welfare.

Associated societies which will hold meetings in conjunction with the Geological Society of America are: Paleontological Society, 37th annual meeting; Society of Economic Geologists, 26th annual meeting; Society of Vertebrate Paleontology, 5th annual meeting.

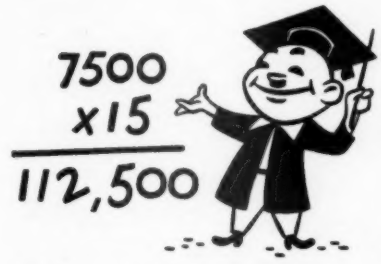
It happens all the time!

A man buys a Mack.



And he watches it work.

And then — it happens...
just as it did in the case of
La Gloria Butane Sales Company
of Fremont, Texas.



La Gloria bought this Mack
EHT 15 months ago for hauling
butane and propane.
Put it through a grind of
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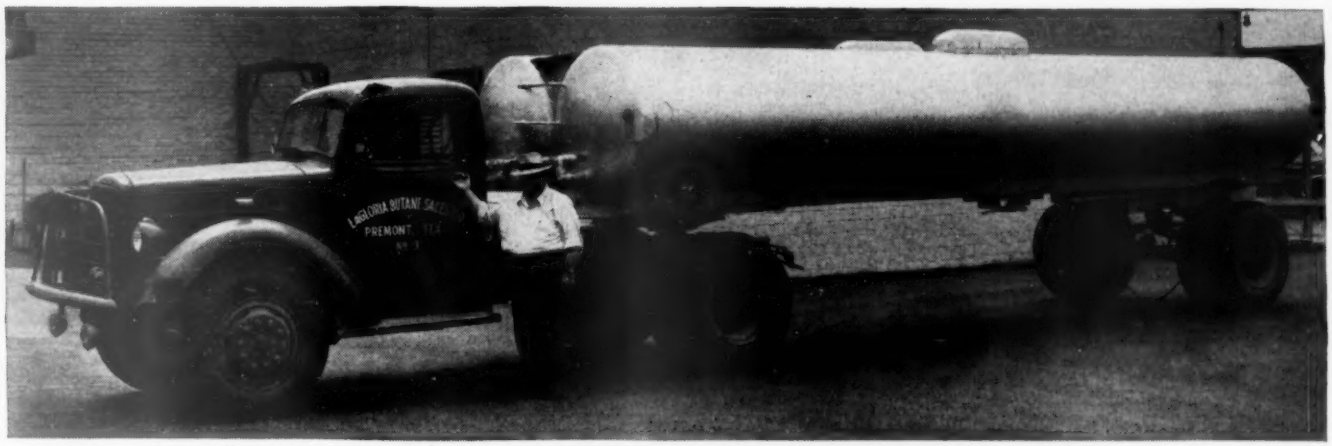
And kept tabs on its performance.

Like it? You bet they did.
Liked it so well
they bought four more.

And today La Gloria's fleet
is 100% Mack.

An old story for Mack—
with a moral for you. How
can you go wrong with
a truck that keeps so many
experienced fleet operators
coming back for more?



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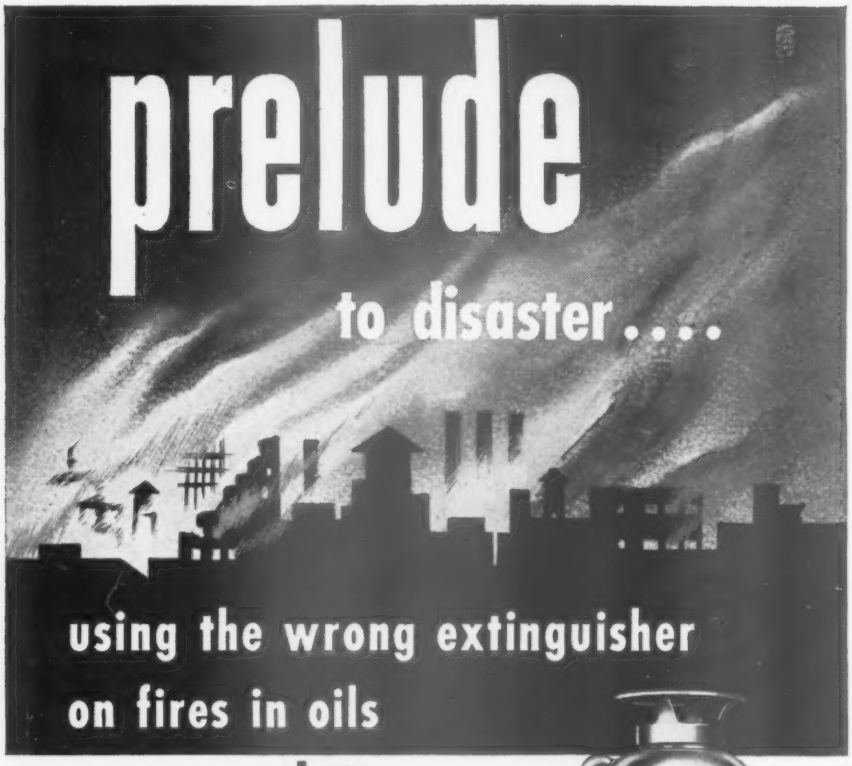

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Army, Navy Worked As Unit on Aleutians and Alaskan Oil Projects

By NPN Staff Writer

KODIAK, Alaska—Army and Navy did more than co-operate in the handling of petroleum products in Alaska and the Aleutians during the war—the two services worked essentially as one unit, Capt P. C. Corning, supply officer of the 17th Naval District, told NPN's writer in an interview at the Navy Officers Club here.

Capt. Corning, a regular Navy officer, enthusiastically praised the Army-Navy Petroleum Board and the men who ran it. He credited A-NPB with providing excellent machinery and practical men for the joint handling of petroleum products.

Along the Aleutian chain, he said, the Navy assumed primary responsibility for obtaining stocks of black oil, Diesel fuel, motor fuel and avgas. Lube oil was mostly an Army job. A like arrangement covered the rest of Alaska except for Ladd Field at Fairbanks and the Nome area, where the Army handled its supply problems independently, simply because the Navy had virtually no installations there.

As supply officer of the 17th Naval District (Alaska and the Aleutians), Capt. Corning would get estimates on petroleum needs from his sector supply men. He would combine these requests with figures from the Army. After checking the estimates against previous consumption records and against plans for future operations, he would determine probable Army and Navy requirements for black oil, Diesel, motor fuel and avgas for the district. Each month a requirements dispatch was sent to the Area Petroleum Board at Seattle, which would arrange with A-NPB at Washington for an allocation. Capt. Corning then would set up and control movements of tankers to the district.

There was never a shortage of petroleum in the district, the captain said, though there were some tight squeezes because requests were figured closely. There was always a reserve to meet unpredictable demands.

Lieut. Com. William B. Lockhart, a professor of law at Stanford University before the war, is Capt. Corning's assistant here.

Com. Lockhart estimates that during the war the 17th Naval District handled an average of seven tankers a month to meet Army and Navy needs in Alaska and the Aleutians. The approximate division of products was:

Black oil	57%
Diesel fuel	29%
Avgas	9.5%
Motor fuel	4.5%

Diesel oil, in addition to powering many smaller craft, is used for heating of buildings and in electric power plants on the Aleutians.

Weather along the Aleutians is rough,

OUT.. IN 14 MINUTES BY "SUB-SURFACE" METHOD

U. S. Navy test on 93′ diameter blazing tank shows . . . "SUB-SURFACE" Method of foam applications kills gasoline fires—when properly engineered foam liquid is used.

MEARLFOAM-5 was successfully employed at this U. S. Navy test at Findlay, Ohio in July 1945. The multi-protein, blended foam-producing liquid is the same dependable mechanical (air) foam liquid supplied to the Navy for shipboard and shore base fire-fighting during wartime—and now supplied to the Navy for peacetime protection.

Ask for condensed data sheet describing the properties of this war-born fire-fighter that yields the live, lasting, fire-resistant (air) foam. *Technical assistance available.*

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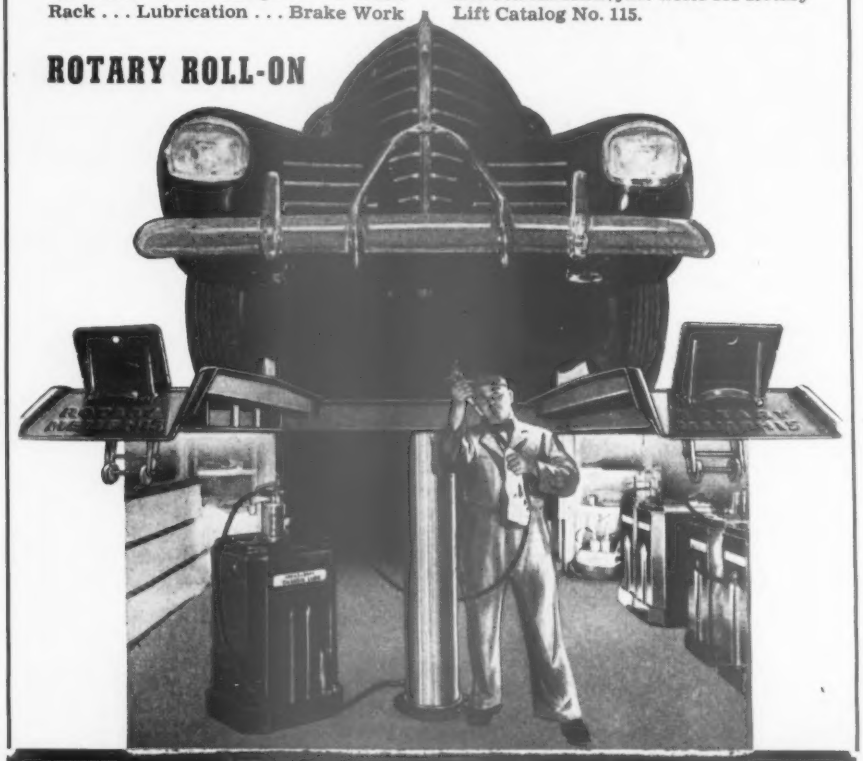
These and many other engineering advances are all incorporated in the new Rotary Lift. The result is an even better lift than the dependable Rotarys you have known in the past. No matter what the job . . . Wash Rack . . . Lubrication . . . Brake Work . . . Underbody Service . . Underparts Replacement . . . they're all done faster, easier, more economically with a Rotary Lift.

If lubrication and oil changing represent the bulk of the work, you'll want a Rotary Roll-On Model with automatic wheel chocks (pictured below). It's the fastest operating of all auto lifts!

For complete information on the latest types of auto lifts, accessories and attachments, just write for Rotary Lift Catalog No. 115.

ROTARY ROLL-ON



Rotary LIFTS

ROTARY LIFT COMPANY, 1075 KANSAS, MEMPHIS, TENNESSEE

but not a single tanker was lost in the 17th Naval District during the war.

One of the special problems of Capt. Corning's command was getting avgas to Shemia and Amchitka on which the Army had important air bases. Shemia, which is just east of Attu, was set up as a B-29 base. Amchitka, a fighter base, is east of Sitka.

Shemia has no harbor into which the Navy can move a large tanker, and Amchitka has terrific tides. Small tankers and barges were used to supply these islands.

To guarantee that these two bases never would be in want because tankers could not get into them, they were put in the same category as icebound ports and were given several months supply.

The Navy's tank farm on Kodiak is very similar to that at Sand Bay on Great Sitkin island, described in a previous article. (NPN Nov. 21, p. 28).

Toluene Plants May Be Sold As Salvage If Not Leased

NPN News Bureau

WASHINGTON — Surplus Property Administrator Symington has advised Congress that SPA proposes to dispose of government-installed toluene facilities as possible salvage if lease or sale cannot be made to present or independent operators.

Reporting that the toluene producing capacity of the nation was increased tenfold during the war, and the capacity of the Baytown Ordnance Works, alone, operated by Humble Oil and Refining Co. at Baytown, Tex., as more than twice prewar consumption of the product, Mr. Symington said:

"Consequently, unless one large new use (for toluene for example as a component of motor fuel) can be developed, it appears . . . that facilities . . . will have to be diverted to other uses, such as other phases of petroleum refining. This conclusion is supported by the existence of a government-owned stockpile of about 20,000,000 gallons of toluene."

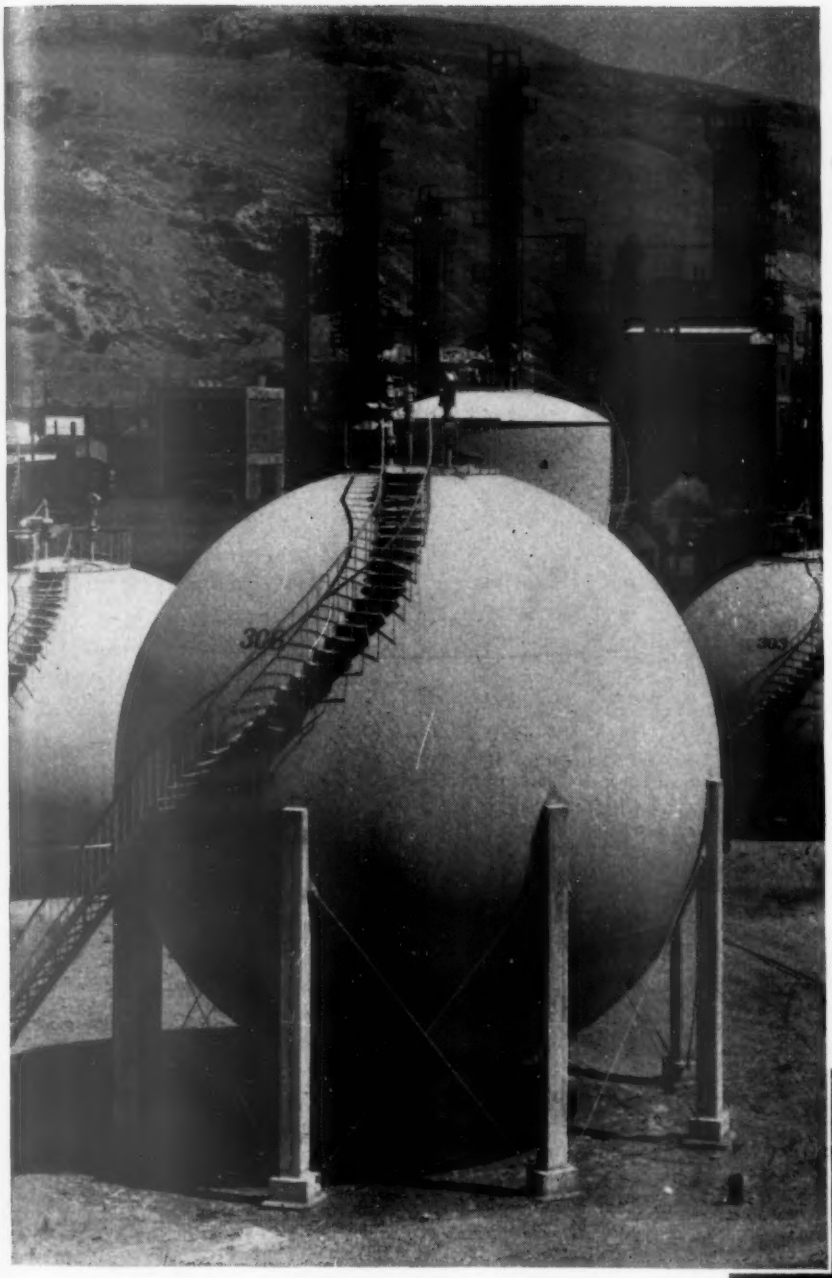
Mr. Symington said that Baytown is only one completed and operated of three petroleum toluene refineries for which expenditures of more than $5,000,000 of U. S. funds were authorized.

The plants of Cities Service Refining Corp., Lake Charles, La., and Phillips Petroleum Co., Borger, Tex., were discontinued after expenditures of less than $1,000,000. Baytown refinery, declared surplus, is under lease on a month-to-month basis to its wartime operator.

Night School for Oil Field Men

Special to NPN

LOS ANGELES—The newly formed Santa Maria Oil & Gas Assn. has begun sponsoring 30-week night courses in field operations. The instructors, Dick Zinszer, Harry Aggers, Don McFaddin and John Adams, will cover petroleum reservoirs, production practices, construction, and refinery absorption and compressor plant practices.

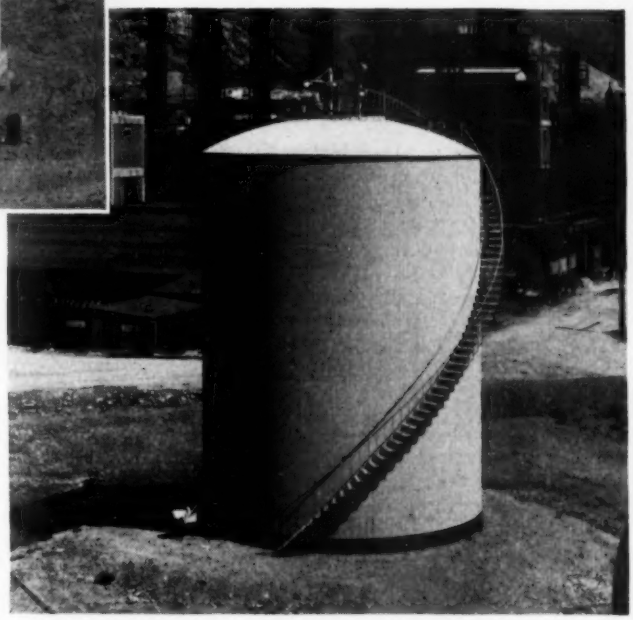


YOU CAN'T *"keep"* VOLATILE PRODUCTS IN ORDINARY STORAGE TANKS

ANYONE who has stored volatile products in ordinary storage tanks and has maintained a careful check of the throughput is aware of the amount of evaporation that can take place during this phase of operation. You simply can't "keep" *all* of the product if you allow evaporation to take place.

At the Utah Oil Refining Company's Salt Lake City refinery, *pressure storage* tanks are used to store the volatile components of the gasoline produced because this type of storage provides maximum protection against evaporation loss. At the left is a Hortonsphere, one of the spherical pressure tanks at this location, which is used to store highly volatile products. It is 38 ft. in diam. and holds 5,000 bbls. It is designed for an operating pressure of 75 lbs. per sq. in. The view below shows a Hemispheroid. This pressure vessel is used to store isomate at 5 lbs. per sq. in. pressure.

All of the Hortonspheres and the Hemispheroids at this location were designed, fabricated and erected by our organization. We will be glad to quote you on *your* pressure storage tank requirements.



HORTONSPHERES . . . *(shown above) widely used for the storage of volatile products. Built in capacities of* 1,000 *to* 25,000 *bbls. for pressures from* 20 *to* 100 *lbs. per sq. in. They are designed to withstand pressures built up in the vapor space at normal temperatures without venting.*

HEMISPHEROIDS . . . *(shown at right) for liquids that are only slightly volatile, requiring operating pressures up to* 10 *lbs. per sq. in. Hemispheroids are built in standard capacities from* 2,500 *to* 20,000 *bbls.*

CHICAGO BRIDGE & IRON COMPANY

Birmingham 1 . . . . . 1534 North Fiftieth Street
Houston 1 . . . . . 5618 Clinton Drive
Tulsa 3 . . . . . 1607 Hunt Building
New York 6 . . . . . 3345-165 Broadway Building
Cleveland 16 . . . . . 2206 Guildhall Building
Atlanta 3 . . . . . 2150 Healey Building

Chicago 4 . . . . . 2125 McCormick Building
San Francisco 11 . . . . . 1260-22 Battery St. Building
Philadelphia 3 . . . . . 1614-1700 Walnut St. Building
Los Angeles 14 . . . . . 1422 Wm. Fox Building
Washington 4 . . . . . 703 Atlantic Building
Havana . . . . . Edificio Abreu 402

Plants in BIRMINGHAM, CHICAGO and GREENVILLE, PENNSYLVANIA

Refinery Crude Stocks Up From August, September Report Shows

NPN News Bureau

WASHINGTON—Crude stocks at refineries totalled 225,079,000 bbls. Sept. 30, up 5,123,000 bbls. from Aug. 31 the Bureau of Mines announced, while September crude runs to stills averaged only 4,275,000 b/d, down 653,000 b/d from the previous week.

About half the decline was attributed by the bureau to a reduction in peak military and export demands and the remainder to shutdowns resulting from strikes.

Also attributed to strikes and declining military demand was a 691,000 b/d drop in domestic crude demand to 4,233,100 b/d.

The bureau said crude production averaged 4,413,000 b/d, down 457,000 b/d from the August level, with largest cuts in following states: Texas, 337,000 b/d; California, 54,000 b/d; Illinois, 16,000 b/d; and Wyoming, 15,000 b/d.

Oil well completions totaled 1,389 in Sept., 231 above August and largest number since Dec. 1941, the bureau reported. Gains of 90 and 59 in Texas and Oklahoma, respectively, contrasted with a California loss of 25.

Texas Refineries Report Upswing

Special to NPN

HOUSTON,—Tex. — Ten operating Texas Gulf Coast independent refineries reported crude runs to stills for the first half of November of 103,363 b/d, 80% of rated capacity.

The report was made to Gulf Coast Refiners' Assn. All-grade gasoline-naphtha increased in the first half of November by 121,997 bbls., and was reported at 1,437,664 bbls. A year ago total gasoline stocks were 1,544,365 bbls.

Aviation gasoline stocks Nov. 15 were 474,172 bbls., a decrease of 48,353 bbls. from the 586,564 reported Nov. 1. Automotive gasoline stocks alone were 689,088 bbls. Nov. 15, a decrease since Nov. 1 of 125,817 bbls., indicating a low inventory. A year ago these stocks were 576,498 bbls.

Elevator Shaft Used to Discover Spherical Catalyst Particles

NPN News Bureau

CHICAGO — Scientists at Standard Oil of Indiana have perfected a way to make new experimental catalyst particles spherical instead of doughnut-shaped.

The development is expected to make the catalyst last longer and is accomplished by dropping the particles through a taller tower.

Since no tower tall enough for the experiment was available, resourceful researchers used the 19-story elevator shaft in the company's general office. With a spray gun, they dispersed the catalyst solution in the top of the shaft and caught it in a box on the top of the elevator on the ground floor.

New Type Combustion Head for Domestic Oil Burners Designed

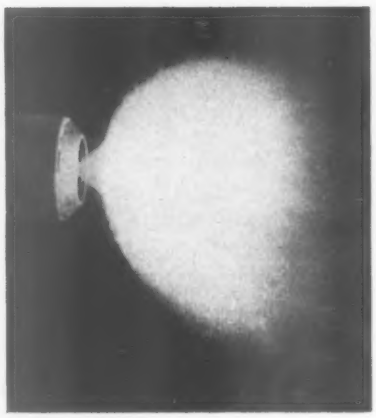
NPN News Bureau

NEW YORK—A new type of combustion head for domestic oil burners, designed to reduce fuel consumption by as much as 20% and thus save millions of dollars in the nation's annual heating bill, was announced here recently by Shell Oil Co., Inc., after a preliminary public showing at the company's Sewaren, N. J., burner testing laboratory.

The new device, described as "another step in the direction of utilizing to the fullest extent every ounce of heat that is available in a gallon of oil", follows research conducted by Shell during the recent oil shortage. The company will make it available to burner manufacturers under a license for incorporation in new burner units.

"The new burner head," a company announcement said, "is particularly important today because of the gigantic home construction program now getting underway. Authorities have predicted a building program of one million homes a year for the next 10 years to fill housing demands. Shell marketing experts have estimated that in this new building program, at least 3,700,000 domestic oil burners of various types will be in use by 1950, consuming a total of 7,770,000,000 gals. of heating oil a year."

Applicable to all gun-type domestic burners, the new Shell combustion head is reported to increase burning efficiency by achieving a more thorough mixture of oil and air, with consequent reduction in the amount of cold air intake needed.



NEW TYPE Shell burner head side view: Even when burning out of the firebox the Shell burner head exhibits high flame retention properties

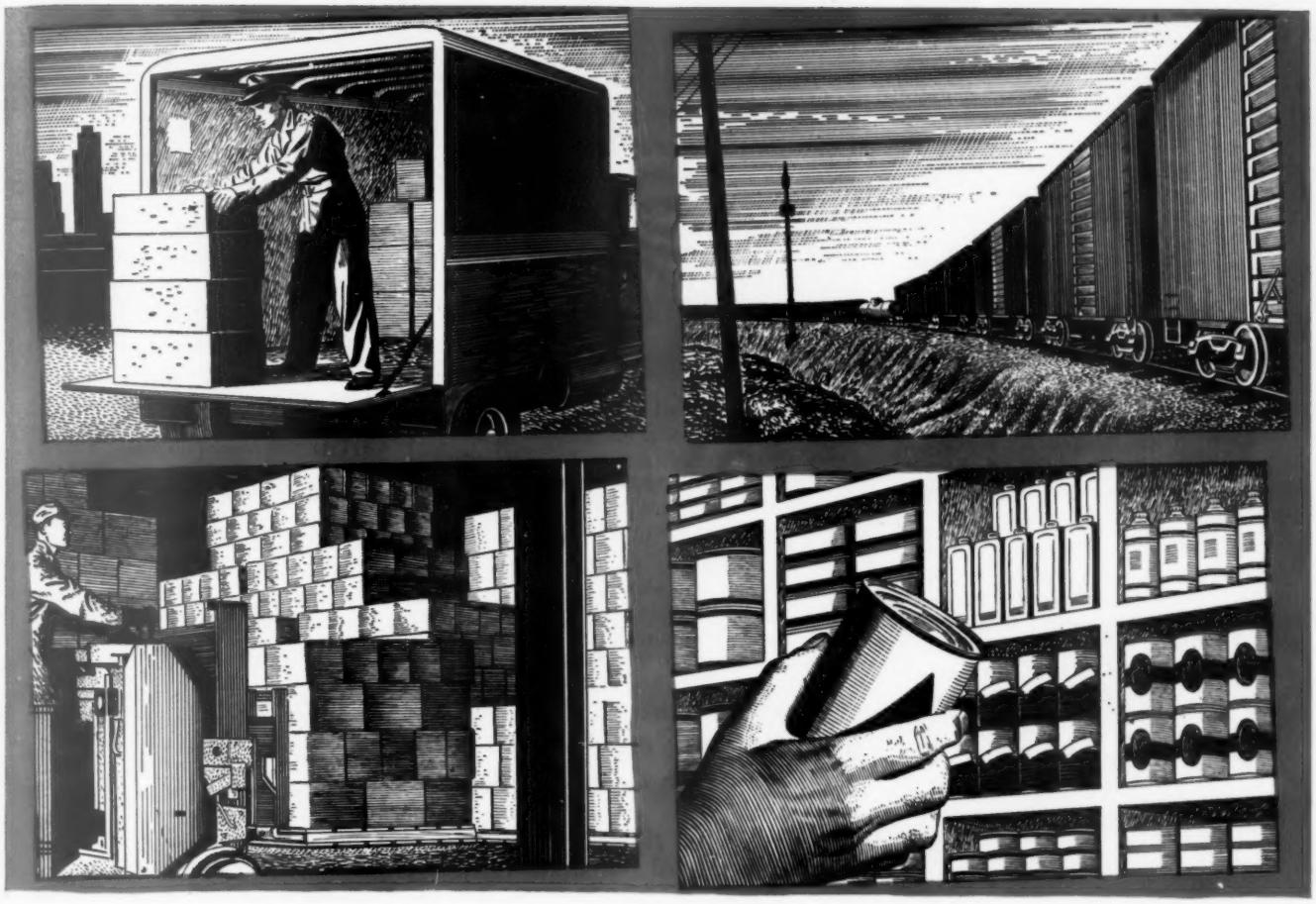
CONVENTIONAL burner head, side view: A ragged unstable flame typical of inefficient combustion

Shell engineers explained that excessive amounts of cold air intake, tend to cool combustion chamber and permit much of the heat to escape by way of the flue. Because of the thoroughness with which oil and air mixed in the new combustion head, smoke and carbon deposits are virtually eliminated when the burner is properly adjusted, the announcement said.

One of the factors that prompted the new development, it was added, is the increasing use of fuels made by catalytic cracking units. These new fuel oils have a higher heat content than prewar fuels but require more thorough mixtures of air and oil to be used to best advantage. Shell engineers said that tests show their new burner head can operate with new fuel oils and with those made by conventional processes without changing the burner adjustment, and that greater efficiency and fuel economy can be obtained in either case.

The possibility of adapting the new combustion head to gun-type, pressure-atomizing burners which are already installed is now under consideration, it was revealed.

"As far back as 1930," the announcement said, "Shell pioneered in advocating that heating oil be made with the same care and precision as motor fuel."



How a Piece of STEEL and a Little TIN Save You VALUABLE SPACE!

● On trucks and trains . . . in warehouses . . . on busy retail shelves . . . space costs money. But you can cut down those space costs by packing your motor oil in compact steel-and-tin cans.

Yes, steel-and-tin cans . . . which are more than 98% steel, less than 2% tin . . . are real space-savers because they can be safely stacked in minimum storage space and effectively used in any kind of service station island display. And motor oil packed in fire-resistant metal containers can be safely shipped in low-cost non-compartmented cartons while still fully complying with the I.C.C. laws governing the shipment of inflammables.

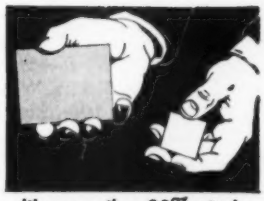
What's more, tamper-proof cans eliminate danger of substitution . . . assure motorists full measure of clean, dependable oil . . . build up brand preference for *your* motor oil. So, for perfect packaging protection and all-round space economy, pack your motor oil in trouble-free steel-and-tin cans.

Real Packaging "Know How" Calls for Motor Oil in Cans

1. Cans are fire-resistant.
2. Don't break or chip.
3. Are economical to ship . . . require no costly packing or special handling.
4. Tamperproof cans assure full measure of clean, dependable oil.
5. Cans are light, compact . . . save shelf and storage space.

Promoting *Cans* from Coast to Coast

Full-page, full-color advertisements are bringing the story of the advantages of buying merchandise packed in cans right into the homes of America's consumers. More than 32,000,000 of these informational advertisements will appear in the nation's favorite magazines and the magazine sections of Sunday newspapers this month.



It's more than 98% steel, less than 2% tin

CAN MANUFACTURERS INSTITUTE, INC., NEW YORK

NO OTHER CONTAINER PROTECTS LIKE THE CAN

One Carthage Company Settles Dispute With Royalty Owners

Special to NPN

AUSTIN, Tex.—At least one company has settled its dispute with royalty owners in the rich Carthage gas field.

A company spokesman said an agreement was reached with Panola Royalty Owners Assn. whereby all differences were settled. He said injunction proceedings restraining the laying of gathering lines have been dismissed and Chicago Corp. is now actively engaged in completion of a field-wide gathering system.

The chief controversy was over payment of royalty on liquid products extracted from gas, settled by agreement to pay ⅛ royalty on 100% of the natural gasoline at market value, less 20c per bbl., after Jan. 1, 1951.

"Until that time Chicago Corp. will pay royalty on ⅛ of the sale price of residue gas plus ⅛ condensate recovered in separators at the mouth of the wells, plus ⅛ of 20% of the value of natural gasoline recovered from gas passed through a separator."

The company is erecting the plant designed to handle 125,000,000 cu. ft. of gas daily, from which it expects to extract 125,000 gals. of liquids daily.

Latest Railroad Commission reports show 1950 gas wells and three oil wells in the Carthage field, including 120 gas wells without any pipeline connection. As of Jan. 1, 1945, Jack K. Baumel, director of production, estimated Carthage's recoverable reserve at more than 3,000,000,000,000 cubic feet.

Believes East Texas Field Will Continue Output 24 Years

Special to NPN

TYLER, Tex.—W. S. Morris, manager of the East Texas Salt Water Disposal Co., believes that the big East Texas field will continue to produce profitably for 24 years under the present proration schedule.

Mr. Morris said geologists have estimated the original field contained five billion bbls. of oil and less than one half of that amount has been produced. The injection of millions of bbls. of salt water into the producing structure has done much to insure a greater recovery of the crude as well as preventing pollution of the Texas streams, he declared.

Consumers Co-op Assn. Buys Wolf Creek Oil Property

Special to NPN

KANSAS CITY—Purchase of the Wolf Creek Oil Co., Wichita, Kans., by the refining subsidiary of Consumers Co-op Assn., was announced Nov. 29 by Howard A. Cowden, co-operative president, in an address to delegates attending the association's 17th annual meeting.

The wells, located in Butler, McPherson, Salines and Russell counties, with present production of 1100 b/d of crude, bring to 436 the total number of producing wells owned by the association. In addition to 46 producing wells acquired by the deal, some 12,000 acres of undeveloped leases were included in the purchase, Mr. Cowden said.

The co-operative, presently owning three refineries and with an interest in a fourth, will now be able to produce 25% of its crude oil requirements, Mr. Cowden said. Last year it marketed 21,544 carloads of refined fuels to 907 member associations in nine states.

Oil, Gas Fields, Pipelines, Refineries Given on Illinois Map

Special to NPN

URBANA, Ill. — The new oil and gas map of Illinois dated Jan. 1, 1945, has just been published by the Geological Survey Division and copies may be obtained from the Illinois State Geological Survey, Urbana, according to announcement. Regular price for the map is 35c per copy but one copy is available free to citizens of Illinois until Feb. 1, 1946.

The new map shows the location and extent of 257 oil and gas fields in Illinois and also the locations and names of refineries, large natural gasoline plants and principal pipelines. A map showing only oil fields but not refineries and pipelines may be obtained also.

War time censorship, according to Dr. M. M. Leighton, chief of the division, delayed publication of this revised map showing 110 new oil and gas fields since the August, 1941, map was issued.

Domestic Crude Below Demand

NPN News Bureau

WASHINGTON—Bureau of Mines today estimated December domestic crude oil demand at 4,542,000 b/d, or 58,000 b/d less than the demand forecast for November.

Breakdown of estimate by states follows:

Texas, 1,940,000; California, 850,000; Oklahoma, 388,000; Louisiana, 365,000; Kansas, 268,000; Illinois, 213,000; New Mexico, 102,000; Wyoming, 92,000; Arkansas, 78,000; Mississippi, 48,000; Michigan, 47,000; Pennsylvania, 36,500; Kentucky, 29,000; Montana, 22,000; Colorado, 20,000; Indiana, 13,500; New York, 13,500; West Virginia, 8,200; Ohio, 7,000; Nebraska, 800; Other, 500.

OPA Boosts Ceilings in 21 Pools Ranging from .02 to 35c Per Bbl.

NPN News Bureau

WASHINGTON—OPA's stripper subsidy program for 21 additional pools allows crude ceiling increases of .02 to 35c per bbl. since Nov. 1, as follows:

OKLAHOMA: Atlantic, 20; Barker, 35; Empire, 35; Kendrick, 17; Lovell, 25; March North, 20; Norfolk West, 25; Seminole East, 25; Signal Hill, 20; St. Louis District, 20; St. Louis North, 35; and Tuskegee East, 20.

TEXAS: Hendrick, 25; Iatan-East Howard, .02; Lubbock, 35; Remo (Osborne area), 25; Teci (Osborne area), 25.

OTHERS: Mountain View, Calif., .02; Ft. Collins, Colo., 24; Catherine, Kan., 25; and Lake Mongoulis, La., 24.

Action came under amendment 9 to order 37 under revised MPR 436.

Houston Operator Sells Half Interest in Conroe Leases

Special to NPN

HOUSTON, Tex.—George W. Strake, Houston independent operator, has confirmed sale of ½ interest in four leases in the Conroe oil field in Montgomery County.

Details were not disclosed but it was reported the deal involved some 1300 acres and the consideration was $8,500,000.

Reported purchaser was a New York syndicate headed by Dillon, Read & Co. The other ½ interest in the four leases involved is held by Tide Water Associated Oil Co. The Conroe field is one of the major oil fields on the Texas upper coast. It was discovered in December, 1931, and has produced to date some 165,000,000 bbls., with estimated recoverable reserves placed at 424,000,000.

Domestic, Foreign Crudes Down

NPN News Bureau

WASHINGTON—Domestic and foreign crude stocks totaled 219,363,000 bbls. at close of week ended Nov. 24, down 1,140,000 bbls. from previous week, the Bureau of Mines announced.

There was a decrease of 938,000 bbls. in domestic crude stocks and a decrease of 202,000 bbls. in foreign crude. Heavy crude stocks in California totaled 4,656,000 bbls., up 192,000 bbls.

Major increases were in Rocky Mountain, up 128,000 bbls., and California, up 117,000 bbls.

Major decreases were in Texas, down 1,148,000 bbls., and Appalachian, down 127,000 bbls.

Start Drilling Standard Well

Special to NPN

ELIZABETH CITY, N. C.—Noble Drilling Co. started work last week on the Standard Oil Co.'s first exploratory oil well in North Carolina. The drilling site is situated near Elizabeth City.

WITHOUT QUESTION, THE *Finest Hose Nozzle* EVER DESIGNED

The McDonald Super Nozzle has everything you ever hoped for in a hose nozzle. Special design permits drop-by-drop discharge without trace of jerk or chatter. Spout, tapering quickly from regular size to 13/16" outside diameter, provides clearance for escape of air and vapor when filling tank—removes blow-back hazard. Molded metallic packing eliminates leakage and maintenance expense. Tapered spout minimizes turbulence and friction. Built-in check valve cannot become cocked—furnished only when requested. Ample hand space avoids cramping and pinching of fingers. Fits all makes of meter pumps—listed as standard by Underwriters' Laboratories. . . . Write for detailed description.

A. Y. McDONALD MFG. CO.
"The Home of the Swing Joint"
DUBUQUE, IOWA

THERE'S A McDONALD BRANCH OR DISTRIBUTOR NEAR YOU

McDONALD SUPER HOSE NOZZLE

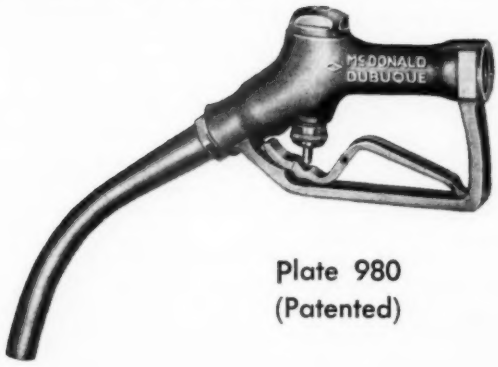


Plate 980
(Patented)

SIZES: ¾" and 1"

McDONALD

SUPER HOSE NOZZLE

Tankers To Be Sold at 60% Prewar Cost, Not Leased

NPN News Bureau

WASHINGTON — There will be no "chartering" of tankers.

The Senate Commerce Committee reported favorably last week on S. 292—the Ship Sales Bill—agreeing to sell tankers at 60% of their prewar cost, but refusing to lease them to citizens or non-citizens.

Failure to enact the measure in its present form might jeopardize all sales, Sen. George L. Radcliffe (D.-Md.) told a recent press conference. He plans to move for early Senate action on the bill.

It was decided, he said, to ban "chartering" of tankers because there "seems to be a better market" for them than for other types of vessels.

Points of difference between tanker provisions of the House of Representatives measure—(H. R. 3603)—and the version reported out by the Senate Commerce Committee, are these:

Disposal price: The Senate version sets the tanker disposal price at 60% of prewar.

"Recapture" clauses—Unlike the House, which struck a "recapture" clause from its version, the Senate committee voted to permit the government to "charter or take" tankers and other vessels from American purchasers within five years from termination of "national emergency."

Sales to foreigners—Foreigners (nationals of other countries) may purchase tankers, under the terms of the Senate Bill, 90 days after the sales notice appears in the Federal Register.

Orders 11% Cut in Rates on Oil Truck Shipping in Florida

Special to NPN

TALLAHASSEE, Fla.—According to announcement by Chairman E. S. Matthews, the Florida Railroad Commission has ordered an average reduction of 11% in rates charged for shipping petroleum products by truck inside the state, effective Dec. 3.

Chairman Matthews said the commission will hold a public hearing in Jacksonville Jan. 5 on proposals to set up uniform or related petroleum shipping rates for truck, rail and water carriers.

Commission Has Surplus Tanker Bid Invitations

NPN News Bureau

WASHINGTON — Invitations to bid on 11 twin-screw and one single-screw dry and liquid cargo tankers recently declared surplus by the Army are now available from U. S. Maritime Commission district offices.

Bids, which were to be opened this week at Washington, may be submitted by non-citizens as well as citizens, the commission said, but bids submitted in behalf of "firms, corporations, associations, or persons included in the Proclaimed List of Certain Blocked Nationals will not be considered."

The tankers, currently located at Charleston, S. C., are "Y" types capable of a speed of 9 knots, and are described by Maritime as follows:

A single screw Y-31 is 162½ ft. in length, 37 ft. in beam and 13.10 ft. in depth, of 690 tons dwt., gasoline cargo capacity of about 6000 bbl., 95% full, and dry cargo hold space of 2370 cu. ft.

Twin-screw tankers measure 182 ft. in length, 30 ft. in beam and 13½ ft. in depth, with liquid cargo space of 37,685 cu. ft. holding about 7000 bbls. of gasoline. Dry cargo capacity is listed at 48.1 long tons and 2405 cu. ft. holdspace. Equipment includes two gasoline pumps of 650 gal. per min. each. Fuel tanks hold about 225 bbls. capacity.

The tankers' government number, builder, year built and engines are listed as follows:

Govt. No.	Builder	Year Built	Engines
Y-31	Kyle & Co.	1944	400 HP Enterprise Diesel
Y-41	Odenback Shipbuilding Co.	1943	240 HP Fairbanks Morse Diesels
Y-42	Odenback Shipbuilding Co.	1943	240 HP Fairbanks Morse Diesels
Y-50	Lancaster Iron Works	1944	315 HP Cooper-Bessemer Diesels
Y-70	Odenback Shipbuilding Co.	1944	350 HP Clark Diesel MD-4
Y-71	Odenback Shipbuilding Co.	1944	350 HP Clark Diesel MD-4
Y-81	Odenback Shipbuilding Co.	1944	350 HP Clark Diesel MD-4
Y-88	Odenback Shipbuilding Co.	1944	350 HP Clark Diesel MD-4
Y-91	Odenback Shipbuilding Co.	1944	315 HP Cooper-Bessemer Diesels
Y-104	Kane Boiler	1944	230 HP Wolverine Diesels
Y-105	Kane Boiler	1944	230 HP Wolverine Diesels
Y-106	Kane Boiler	1944	230 HP Wolverine Diesels

Plan to Defer Key Oil Scientists, Engineers

NPN News Bureau

WASHINGTON—Selective Service announced last week a plan to defer the oil industry's physical scientists and engineers pursuing advanced studies in their respective fields. A similar plan will be in effect for technical men in other industries.

OWMR Director Snyder requested the plan "to fully develop the technical and scientific skills which have been acquired and to provide adequate teaching facilities for returning veterans who desire to resume their studies in these fields."

Memoranda to local boards requests "serious consideration" be given to occupational deferment of registrants in the long-range national interest as follows:

"1. Advanced students in the physical sciences or engineering.

"2. University teaching in the physical sciences or engineering.

"3. University research in the physical sciences or engineering—(A) Any registrant (1) who is to be employed by or attached to the staff of an accredited college or university for research (in those fields) and (2) who signifies his intention to engage in such an activity may be certified to the director of Selective Service as essential to the national interest in a civilian capacity; (B) such a registrant will be certified only if (1) the research to be undertaken by the registrant contributes significantly to the national interest and, (2) inability of the individual registrant to undertake the research will result in its delay."

Registrants wishing to be certified under the new plan must present to the Office of War Mobilization and Reconversion, Washington, the following documents in triplicate:

1. Notarized statement of intention to undertake graduate studies leading to a master's or doctor's degree in physical sciences or engineering or to teach or undertake advanced studies in those fields.

2. Statement from the college or university supporting this statement of purpose.

3. Registrant's name, address, age, Selective Service local board number and address, classification and educational qualification.

OWMR may also certify any registrant as essential if he has satisfactorily completed at least three years of work leading to a bachelor's degree in physical sciences or engineering and served at least two years in a project directly connected with the war effort.

The latter type of registrant must submit to OWMR, the following documents in triplicate:

1. A notarized statement of his intention to continue undergraduate studies leading to a B.S. or M.A. degree in the physical sciences or engineering.

2. A statement signed by an accredited college or university supporting this contention that he has been accepted for

fourth-year study course leading to B. S. or B. A. degree in physical sciences or engineering.

3. Statement showing registrant's name, address, etc., as in No. 3 above.

4. A statement from registrant's employer that he has been engaged for at least two years in scientific war work.

Arkansas-Louisiana Division Of Mid-Continent Assn. Meets

Special to NPN

SHREVEPORT, La.—The first assembled meeting of the Arkansas-Louisiana division of the Mid-Continent Oil and Gas Assn. since the war, elected A. R. Carmody of Shreveport the new president, succeeding A. R. Tarver.

During the war election of officers and association business had been carried on by mail. Following the meeting of the general membership the association's executive committee also held a session.

The new president is head of the North-Central Texas Oil Co. Other new officers elected were: vice presidents, John J. Frommer, Ohio Oil Co.; Joe T. Goodman, Gulf Refining Co.; A. H. Weyland, Arkansas-Louisiana Gas Co.; A. H. Tarver, retiring president; and C. H. Lyons, of Lyons and Prentiss.

To membership in the general association's board of directors were: F. W. Bruner, Carter Oil Co.; B. A. Hardy, independent; J. H. McFarlane, independent; Charles G. Lasky, independent; J. L. Polk, Atlas Oil and Refining Co.; W. H. Rector, Magnolia Petroleum Co.; John M. Starke, Southern Products Co.; and N. H. Wheless, N. H. Wheless Drilling Co.

Main speaker was Clarel B. Mapes, secretary of the general association in Tulsa, who talked on "Federal Questions Affecting the Oil Industry."

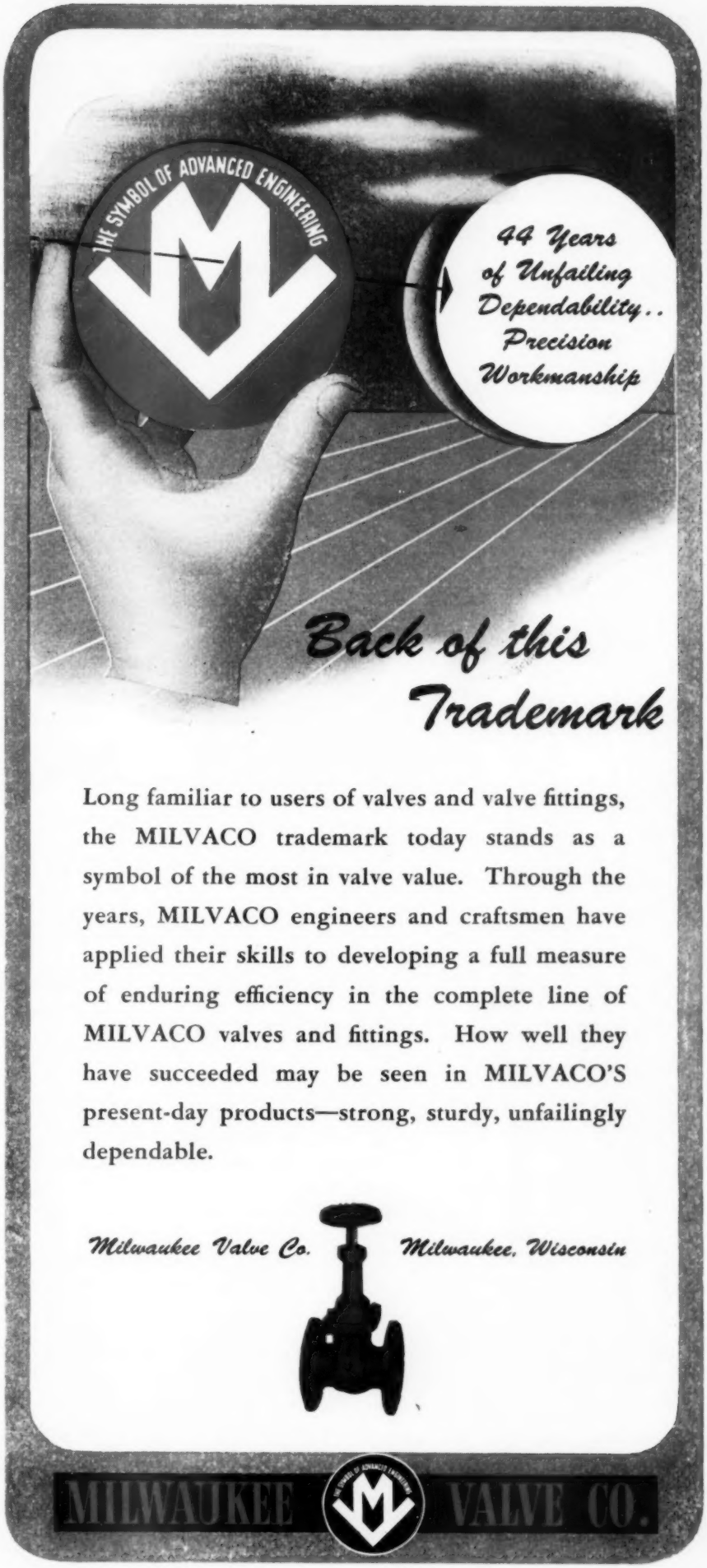
Announces Seaboard Philgas Sale To Suburban Gas Co.

NPN News Bureau

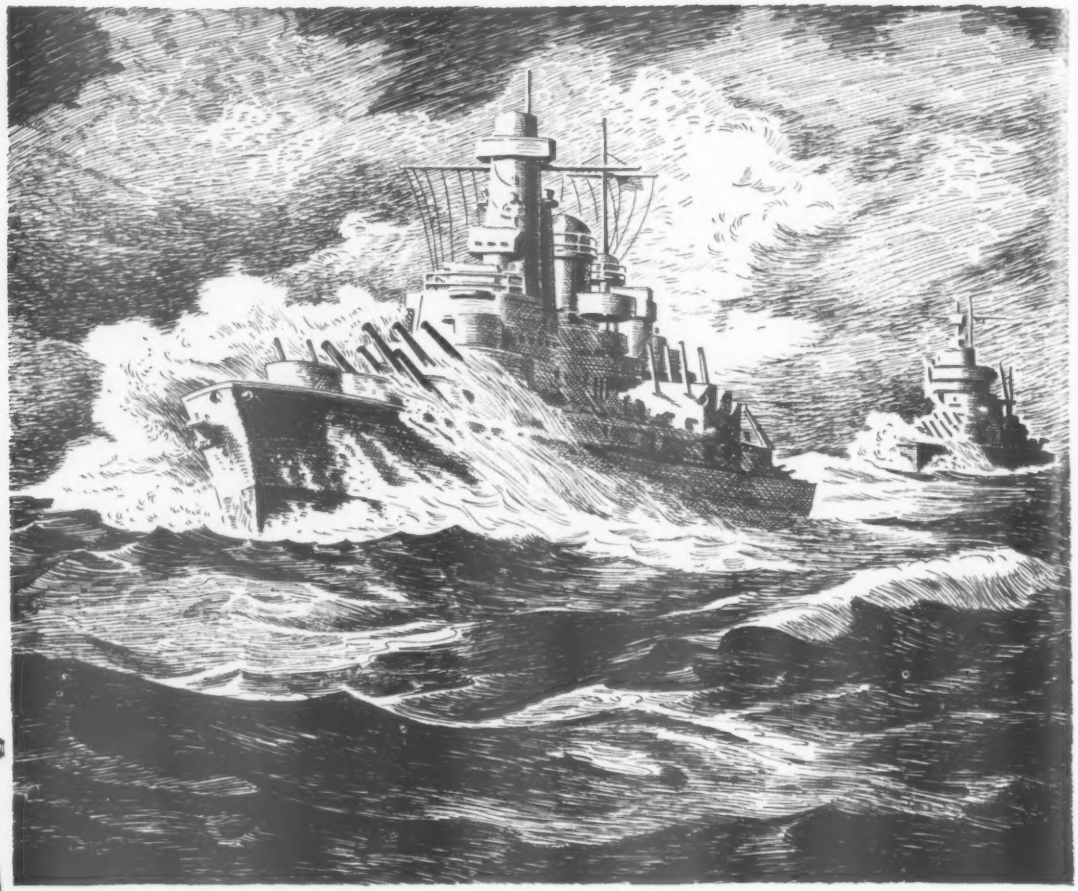
NEW YORK—Phillips Petroleum Co. last week announced sale of its Eastern Seaboard retail Philgas properties, representing largest distribution of bottled gas in the area, to Suburban Propane Gas Co., newly-formed organization. Sale price was $11,000,000.

The sale is conditional on financing by the new company, which filed a registration statement with Securities and Exchange Commission. Phillips will continue its industrial and wholesale marketing of liquified gas in the east, and will supply the new company with all its liquefied petroleum gas requirements. No change in ownership throughout other Phillips' marketing territories is contemplated.

Frank Phillips, chairman, and K. S. Adams, president, of Phillips said the sale of Eastern Seaboard retail bottled gas business will permit Phillips to concentrate on operations nearer the center of the company's oil activities in the middle west.


THE SYMBOL OF ADVANCED ENGINEERING
44 Years of Unfailing Dependability.. Precision Workmanship
Back of this Trademark
Long familiar to users of valves and valve fittings, the MILVACO trademark today stands as a symbol of the most in valve value. Through the years, MILVACO engineers and craftsmen have applied their skills to developing a full measure of enduring efficiency in the complete line of MILVACO valves and fittings. How well they have succeeded may be seen in MILVACO'S present-day products—strong, sturdy, unfailingly dependable.
Milwaukee Valve Co.
Milwaukee, Wisconsin
MILWAUKEE VALVE CO.

VITAMIN FOR BATTLE WAGONS



Q: How PROGRESSIVE is the oil industry?

A: As PROGRESSIVE as its research in many fields . . . for example: Research on RUST CONTROL

YEARS before Pearl Harbor, Shell research scientists were taking molecules apart and rearranging them—seeking a natural "vitamin" to prevent rust in the turbines that drive ships and power industry . . .

And they found it—in time to meet the greatest need in our Navy's history. Invisible, like a natural vitamin, when it is added to turbine oil a moisture-resistant film forms over the metal, protecting the lubricated parts against rust under severe operating conditions.

Today, our turbines have been stepped up in efficiency to a point where they consume less fuel than those of any other Navy—giving Yankee ships greatly increased range.

Such research—with its proved achievements—is a great factor in the steadily growing prestige of the oil industry. Shell Research works tirelessly today—to make petroleum serve mankind in more ways.

SHELL

Horizons widen through Shell Research

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COMPLIANCE SERVICE ON OIL REGULATIONS

Digest of Regulations Issued Weekly Regarding Oil and Oil Equipment

Index of Week's Oil Orders

(Nov. 24-Dec. 1, 1945)

PAW—Petroleum Administration for War

Directive 59, Revocation—Pooling directive revoked

OPA—Office of Price Administration

MPR 28, Am. 14—Ethyl alcohol ceilings

MPR 88, Am. 37, Clarification—Reduction in heavy fuel oil ceilings

MPR 170, Order 10—Di-ethylene glycol type anti-freeze ceilings

SO 28, Revocation—Rules abolished as to applications for price adjustment based on a wage increase requiring NWLB approval

CPA—Civilian Production Administration

Haulage Request TR-2, Revocation—Restrictions on transportation and storage of certain materials abolished as of 12-31-45

M-300, Schedule 71, as am. 11-26-45—Ethyl alcohol restrictions

R-1, App. II, Am. 1—Manufacture of tire tubes

Directive 27 as am. 11-27-45—Foreign priorities action

Department of Commerce, Office of International Trade Operations

Gen. Export Regs., Am. 103—Prohibited exportations

Am. 104—General license for metal drums and containers

Am. 106—Blockade control permit no longer required for petroleum and products

Current Export Bulletin 294—Revision of export controls

Current Export Bulletin 295—Changes in export rules

OSA—Office of Stabilization Admr.

Directive 88—Reconversion pricing

ODT—Office of Defense Transportation

AO ODT 1, as am., Partial Revocation—Another section revoked

AO ODT 29, Partial Revocation—Delegation of authority to 2 Dept. directors revoked

RFC—Reconstruction Finance Corporation

Reply to Senator Moore—Proposed designation War Assets Corp. as surplus property disposal agency

FTC—Federal Trade Commission

Docket 4389, Order to Cease & Desist—Price discrimination among purchasers forbidden

Dept. of Labor

Order Creating Fact-Finding Panel—Appointment of 3 members to investigate oil wage dispute

OIL-LAW-GRAM Service

Complete texts of all orders or amendments digested in oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

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Digest of Week's Oil Orders

Petroleum Administration for War

POOLING DIRECTIVE REVOKED—Directive 59, Revocation—Pooling discontinued as of 10-1-45, and all inter-company settlements supposed to have been completed by 11-30, effective date of formal revocation. Issued 11-26, effective 11-30.

Office of Price Administration

ETHYL ALCOHOL CEILINGS—MPR 28, Am. 14—A 3½c increase per gal. is allowed manufacturers of industrial ethyl alcohol basic formula produced East of Rockies, and slightly smaller increase is granted other formulas. These ceilings range from .527c for SD 12A to .582c for SD 23G. Jobbers' ceilings are the GMPR-determined ceilings plus 3c per gal. Issued 11-26, effective 11-28.

REDUCTION IN HEAVY FUEL OIL CEILINGS—MPR 88, Am. 37, Clarification—OPA has issued an explanation stating that Am. 37 reduces No. 6 fuel oil refinery and tanker terminal ceilings on eastern seaboard, as specifically stated, and reduces by corresponding amounts No. 5 and No. 6 ceilings at any level where such prices are determined on No. 6 wholesale ceiling. Formula prices at tank wagon level should be reduced to reflect the refinery and tanker terminal ceiling reductions. Issued 11-28.

DI-ETHYLENE GLYCOL TYPE ANTI-FREEZE CEILINGS—MPR 170, Order 10—Manufacturers' ceiling on 98% diethylene glycol anti-freeze is $1.90 per gal.; retailers' cost $2.38; retailers' selling price $3.50. No extra charge for containers permitted. Issued and effective 11-30.

RULES ABOLISHED AS TO APPLICATIONS FOR ADJUSTMENT BASED ON A WAGE INCREASE REQUIRING NWLB APPROVAL—SO 28, Revocation—Issued and effective 11-30.

Civilian Production Administration

RESTRICTIONS ON TRANSPORTATION AND STORAGE OF CERTAIN MATERIALS ABOLISHED AS OF DECEMBER 31st—Haulage Request TR-2, Revocation—Issued 11-27, effective 12-31.

ETHYL ALCOHOL RESTRICTIONS — M-300, Schedule 71 as am. 11-26-45—After 12-1-45 allocations of ethyl alcohol will be made only to primary suppliers for industrial uses and only they need file applications. The allocation application procedure is simplified, and buyers need no longer file purchase applications nor use certificates. Formerly an Appendix C material, ethyl alcohol is now classified as an Appendix B material, which is not applicable, however, to alcohol produced in Wash., Ore., Calif., Ariz., N. M., Nev., Utah, Col., Wyo., Ida., Mont., or imported into other states from outside continental U. S. Issued 11-26.

MANUFACTURE OF TIRE TUBES—R-1, Appendix II, Am. 1—Beginning 1-1-46, manufacture of tubes from GR-1 will be permitted in all sizes and types. Limited to sizes and types listed in Table A until that date. Issued 11-21.

FOREIGN PRIORITIES ACTION—Directive 27 as am. 11-27-45—Rewritten to insert, instead of FEA, name of Office of International Trade Operations, Department of Commerce. Validity of CC ratings properly assigned by FEA or Office of International Trade Operations before 11-27-45 not affected, but such ratings are subject to all applicable CPA regulations. Issued 11-27.

Department of Commerce

PROHIBITED EXPORTATIONS—Gen. Export Regs., Am. 103—Individual license must be secured for export of motor fuel and gasoline from which there can be separated, by commercial distillation, more than 3% of a total fraction having an A.S.T.M. end point of 300° F. which will have, with the addition of 3 cc. tetraethyl lead per gal., an octane number by A.S.T.M. knock test method of 80 or more. Individual license also required for petroleum coke. Issued 11-23.

GENERAL LICENSE FOR METAL DRUMS AND CONTAINERS—Gen. Export Regs., Am. 104—Metal drums and containers filled with commodities whose export has been authorized by individual license or which are under general license may now be exported under general license. Issued 11-19.

BLOCKADE CONTROL PERMIT NO LONGER REQUIRED FOR PETROLEUM AND PRODUCTS EXPORT TO SPAIN—Gen. Export Regs., Am. 106—Spanish possessions and Tangier included in this relaxation. Exporters may now submit export license applications for such shipments without having received a notification to do so from Commerce Dept. Issued 11-16.

REVISION OF EXPORT CONTROLS—Current Export Bulletin 294—The positive list of commodities and various country groupings explained. Issued 11-23.

CHANGES IN EXPORT RULES—Current Bulletin 295—Spanish export relaxations, metal container exports, etc. discussed. Issued 11-24.

Office of Stabilization Administration

RECONVERSION PRICING—Directive 88—Ceilings determined under Directive 78 reconversion pricing formula, or under any other interim formula, may not reflect any legal increase in materials prices occurring hereafter, nor any wage increase approved by any proper agency, unless Price Administrator finds that such reflection is necessary to prevent hardship or to main equitable prices. Issued and effective 11-27.

Office of Defense Transportation

ANOTHER SECTION OF AO ODT 1 REVOKED—AO ODT 1, as am., Partial Revocation—Section relating to Puerto Rico Regional Director revoked. Issued 11-30, effective 12-1.

DELEGATION OF AUTHORITY TO TWO DEPT. DIRECTORS REVOKED—AO ODT 29, Partial Revocation—Functions and authority of Highway Transport Dept. Director and of Liquid Transport Dept. Director abolished. Issued 11-30, effective 12-1.

Reconstruction Finance Corporation

PROPOSED DESIGNATION AS DISPOSAL AGENCY UNDER SURPLUS PROPERTY ACT —RFC Reply to Sen. Moore re War Assets

CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule SO—Supplementary Order; SR—Supplementary Regulation.

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Your company can save on transportation of crude oil and refined petroleum products by using Butcher-Arthur oil barge service. From point of origin to destination, the Butcher-Arthur organization handles your bulk shipment without delay, without using connecting carriers, along the Intra-Coastal Canal from Corpus Christi to Carrabelle, Florida, and to points along the Mississippi and Ohio Rivers and tributaries to and from New Orleans and Mid-West and Eastern terminals.

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——Oil Orders——

Corp.—General Counsel for Petroleum Reserves Corp., newly designated War Assets Corp. by amendment of the charter states that former designation of Office of Economic Warfare to replace RFC as manager of PRC was nullified by Truman's Executive Order transferring PRC to RFC. The Surplus Property Admr. is expected to designate War Assets Corp. soon as disposal agency for all classes of surplus property handled by RFC at time of enactment of Surplus Property Act of 1944. This will include consumer goods, industrial plants, capital goods, and producers' goods. Issued 11-14.

Federal Trade Commission

PRICE DISCRIMINATION AMONG CERTAIN CLASSES OF PURCHASERS FORBIDDEN—Docket 4389, Order to Cease & Desist—Six specific selling practices which have been ruled to be in infringement of the Clayton and Robinson-Patman Acts, are forbidden Standard Oil Company, all relating to discriminations in price between various retail purchasers and certain dealers, jobbers, and wholesalers with whom they are in fact in competition, as set forth at length in last three issues of NPN. Issued 10-9.

Department of Labor

APPOINTMENT OF THREE MEMBERS TO INVESTIGATE OIL WAGE DISPUTE—Order Creating Fact-Finding Panel—Powers, administrative facilities, and remuneration of the three named members outlined. Panel to report to Secretary of Labor within 30 days its findings of fact and recommendations after it has heard both parties as to the merits and as to their views on proper procedure in Panel's hearing of disputants' claims. Issued 11-27.

Gradual Decontrol of Oil Industry by Government Urged

NPN News Bureau

SAN FRANCISCO — Gradual de-control of the oil industry by the government was advocated at a meeting with OPA officials of District 5 Petroleum Products Industry Advisory Committee here. The expressed feeling of industry members was that the government should not completely relax controls at this time but that OPA should institute a program of selective de-control.

Specifically the committee recommended a simplification of OPA regulations to reduce administrative difficulties and lessen confusion. Members particularly stressed the fact that the industry is a buying as well as a selling entity. OPA officials were non-committal since a general OPA policy is now in process of formation.

The only other major topic of discussion was the price of avgas at airports. The price of avgas for automobile use was not discussed.

Expect Favorable Report on Kefauver Monopoly Measure

NPN News Bureau

WASHINGTON—The House Judiciary Committee has voted to issue a favorable report on the Kefauver Bill to amend the Clayton Act by prohibiting any corporation from acquiring the assets of another for monopolistic purposes.

The measure has been re-introduced as a "clean bill" (H. R. 4810) and will be reported to the House in a few days, although action is not expected until after the Christmas recess. The bill was formerly known as H. R. 4519.

Deaths

Funeral services have been held for **Alfred Briggs Irion, Sr.,** 57, who died at his home in Marshall, Tex., of a heart attack. Mr. Irion was head of the Red Iron Drilling Co., a contracting firm widely known in East Texas, Arkansas, Louisiana and Mississippi.

♦ ♦ ♦

Funeral services held last week in Midland, Tex., for **C. C. Newton,** 60, district construction superintendent for Humble Pipe Line Co. Mr. Newton was a Humble employee for 25 years and also had three years service with Prairie Pipe Line Co.

He is survived by his widow, a daughter, Mrs. Thelma Sharp of De Leon; three brothers and three sisters.

♦ ♦ ♦

Edward L. Biersmith, Jr., 45, plant manager of the Columbian Steel Tank Co., Kansas City, Mo., died Nov. 24. Mr. Biersmith was born in Kansas City. Following his graduation from Notre Dame University, he became associated with the Ford Motor Co. He was night superintendent of their Kansas City Branch immediately before joining the Columbian organization.

He is survived by his wife; a son, Edward L. Biersmith, III, and two brothers, John A. Biersmith and Thomas E. Biersmith.

♦ ♦ ♦

J. C. (Chick) Anton, Anton Oil Co., Wessington Springs, S. D., died of a heart attack and was buried in his home town on Nov. 25. His friends attending the South Dakota Independent Oil Men's Assn. convention on Nov. 26, announced his passing. He was 43 and a Socony-Vacuum jobber.

♦ ♦ ♦

E. C. Bourquin, operations manager for the marketing division of Standard Oil Co. (Ohio) since June, 1944, died Nov. 29 at Lakeside Hospital, Cleveland after an illness of several weeks. Burial was held Dec. 1.

Well known throughout Ohio by reason of his 30-year association with Sohio, Mr. Bourquin joined the company at Canton after ending a six-year teaching tenure. After two years he was made traveling inspector of service stations for northeastern Ohio. In 1923 he was placed in charge of service stations in the Cleveland district and was transferred to the home office service station department in 1930. Appointed manager of the Marion division in 1936, he later headed the Columbus division from 1941 until he was placed in charge of marketing operations last year.

He leaves his wife, one daughter, his father and a sister.

House Group to Hear Report on "Big Inch," "Little Big Inch"

NPN News Bureau

WASHINGTON—Investigators for the House Appropriations Committee expect to submit a report next month on their investigation of the "Big Inch" and "Little Big Inch" pipelines.

The report was ordered two months ago by Chairman Clarence Cannon (D.-Mo.) after a letter from RFC to Sen. Joseph C. O'Mahoney (D.-Wyo.), chairman of the Senate Petroleum Resources Committee, showed a net loss of $207,000,000 when pipeline profits were applied to deficit in the East Coast Subsidy Program. Cannon said the investigation was designed "to protect the government's investment."

The report, as ordered by Cannon, will have five parts:

1. Cost of original investment.
2. Cost of operation, both during full operation and for stand-by operation.
3. Revenues and source of those revenues.
4. Plans for disposition, possibility of disposing of the property to private ownership, and determination of what steps have been taken to preserve and maintain the lines if the government is to retain ownership.
5. Any additional information relative to plans for protecting the government's interest.

Gallonage Up in 3 States As Peace Brings Gasoline Demand

NPN News Bureau

CLEVELAND—The end of rationing and the beginning of peacetime driving brought sharp upturns in gasoline sales to three states—Kentucky, South Dakota and Illinois. Figures there for August-September, 1945, compared favorably with the same months last year, as follows:

	1944	1945
Ken. (Sept.)	28,110,169 gals.	20,339,780
S. Dak. (Sept.)	17,418,856	16,684,578
Ill. (Aug.)	118,463,862	99,492,379

Warns Peacetime Co-operation May Ultimately Lead to Jail

NPN News Bureau

NEW YORK—Warning that the kind of co-operation in which the petroleum industry engaged during war may in peacetime lead "but to collusion and collusion leads to jail," was uttered here by Samuel B. Eckert, chairman of Distribution and Marketing committee of PAW Dist. 1, in farewell remarks to that group.

Mr. Eckert's remarks were interpreted as aimed at type of organization which will be proposed to P.I.W.C. by 23-man committee headed by W. Alton Jones, president of Cities Service Co. Mr. Eckert, marketing vice president of Sun Oil Co., said "the same ideas were expressed after the NRA days, and Madison should serve as an everlasting warning!" He was referring to the anti-trust suit against a number of oil companies tried in Federal court at Madison, Wis.

Mr. Eckert said that co-operation of recent years was "engendered by a united determination to win the war, resulting in a total disregard for corporate or personal gain." He declared that "this spirit cannot and should not be expected to apply to relations within the industry after the war."

"For the best interests of our country at large and our own business in particular," he added, "we want to stimulate competition, not to stifle it. It is the spirit of competition that has made this country great and it is the dispirited resorting to cartels and anti-competitive understandings that has spelled the industrial doom of the older nations abroad."

Meanwhile, the 23-member committee was preparing specific recommendations to be included in a report which will be presented to P. I. W. C. at its final meeting in Washington on Dec. 12.

Standard (N.J.) Subsidiary to Work on Atomic Power Problems

NPN News Bureau

NEW YORK — Standard Oil Co. (N.J.) revealed this week it has organized, through its research subsidiary, Standard Oil Development Co., a theoretical physics group whose duties will include investigation of possibilities for applying atomic energy to industrial uses.

Dr. Karl Cohen, who participated in the secret government wartime project which culminated in the discovery of the atomic bomb, will head the new group which, in addition to exploratory research work, will keep abreast of new developments in the field of physics.

Forrestal Changes Mind, Won't Release Aerial Magnetometer

NPN News Bureau

WASHINGTON—Navy's earlier decision to release its airborne magnetic detector so the petroleum industry can use it for oil exploration went by the board this week as Navy Secretary Forrestal vetoed its immediate release.

This means the know-how for adapting the device to all oil exploration may be postponed for several more months.

Mr. Forrestal's accompanying statement indicated he was keeping the device on the restricted list until such time as he can be satisfied the government is fully protected on patents, also for the purpose of allowing the manufacturer of the device to satisfy himself as to just where he stands.

The magnetometer was used extensively against German submarines during the war and oil companies have exerted pressure on the Navy to release the information. Know-how is already in possession of Gulf Oil Co., whose Gulf Research and Development Co., came out with its own aerial magnetometer in 1940.

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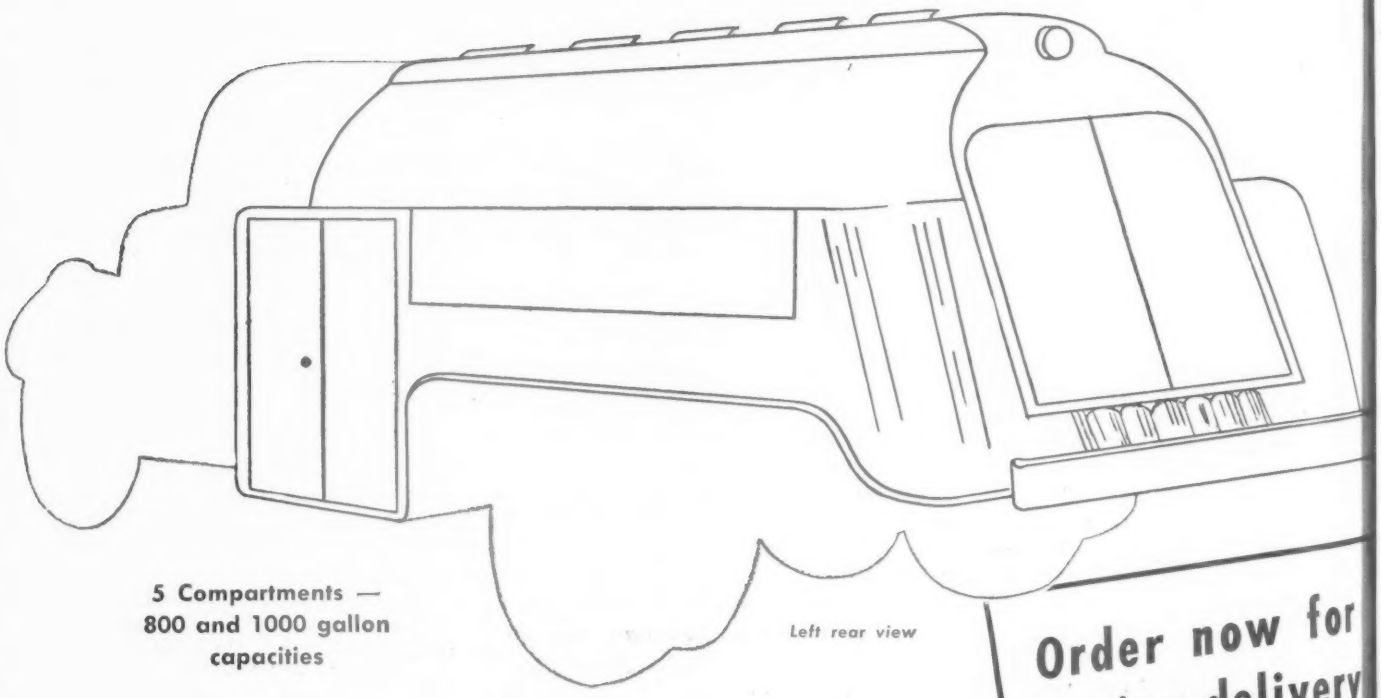

5 Compartments — 800 and 1000 gallon capacities

Left rear view

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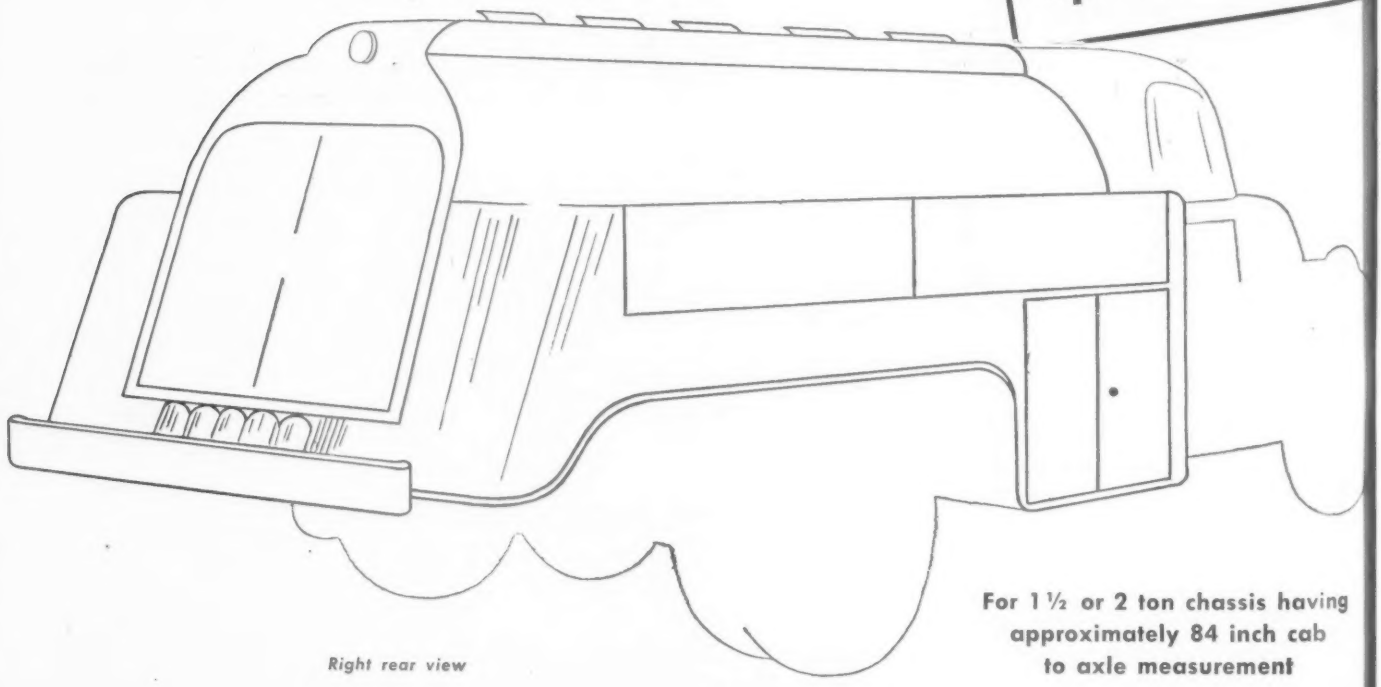

Right rear view

For 1½ or 2 ton chassis having approximately 84 inch cab to axle measurement

...service buy *efficient dependable*

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– and be assured of profitable operation

The following are specifications covering the Heil standardized 800 gallon and 1000 gallon, 5 compartment truck tanks. Compartment sizes front to rear: 800 gallon — 200, 200, 150, 150, 100; 1000 gallon — 300, 250, 200, 150, 100

1. TANK — Mild steel, elliptical shape, smooth-skin, one piece shell construction insures great longitudinal and transverse beam strength. All welds are accessible through manholes. Smooth sides with no tie bands provide unobstructed surfaces for effective advertising messages. Deep-dished, flanged, double compartment heads with air space between compartments are included.

2. MANHOLES — Heil manholes provide 11″ x 16″ opening in each compartment. Manhole is fitted with 10″ diameter hinged filler, adjustable capacity indicator, Heil air vent and fusible metal plugs.

3. BEAVER TAIL — Beaver tail forms integral rear compartment, is equipped with side hinged doors, skeleton wood lining, wood partitions and dial counter. Slope at rear produces graceful streamlined effect. This cabinet is sufficiently deep to accommodate hose reel and meter equipment if desired.

4. SKIRTING — Trim skirting as shown, minimizes maintenance, facilitates cleaning, reduces the effective area for collection of mud and snow, and presents a pleasing appearance.

5. SIDE CABINETS AND DROP-PANEL CAN RACKS

Right Side: Two section, drop-panel can rack will accommodate 5 gallon cans. Floor of can rack is made of steel and covered with hardwood wearing strips. Underslung cabinet is equipped with side hinged doors and is sufficiently spacious, with doors closed, to accommodate full sized barrel or meter and hose reel equipment if desired.

Left Side: Full length safety tread walkway provides ample foot space for inspection and loading operations. Longitudinal specialty cabinet with bottom-hinged panel is located beneath walkway. Vertical type enclosed specialty cabinet with side hinged doors extend full height of side skirting. These vertical and longitudinal cabinets provide facilities and space for carrying specialty items such as canned oil, grease, tires and accessories.

Convenient steps and grab handles are provided at front of tank. Can racks and specialty cabinets are supported without the aid of cross-bolsters. End panels of cabinets are attached to the tank shell and tank longitudinals in such a manner as to allow them to act as load carrying members in addition to serving as enclosures. The load is carried with greater ease and security and with much less dead weight than when hung from cross-bolsters. Watertight construction makes it impossible for water to run down side of tank between walkways and tank into side cabinets.

6. SUBFRAME — Weight-saving Heil subframe consists of steel box section longitudinal members and tapered hardwood sills, which support tank over its entire length and eliminate conventional cross-bolsters. The sills are free from contact with chassis frame for a space of 30″ immediately behind the cab, permitting unobstructed movement of chassis frame.

7. PIPING — To eliminate joints and flow restrictions, each compartment is fitted with 2″ light weight steel tubing with large sweep bends. Outlets are located at front of each compartment, and pipe lines are pitched for complete drainage. A 2″ Wheaton faucet, type 31, is provided for each line. Outlets in tank compartments are designed for installation of emergency valves if desired.

8. HOSE TUBES — To accommodate 2 lengths of 2″ hose, the tubes form the longitudinal support of tank, terminating in rear housing.

9. LIGHTS — Unit is equipped with 4 electric running lights as well as one combination stop and running tail light at rear. All wiring for lights is water-proof.

10. FLASHING — Flashing is provided full length of tank on each side of manholes to protect as well as partially conceal manholes. This flashing is blended into the streamlined design of rear housing.

11. BUMPER — Hinged bumper transfers shock to end of sills and protects faucets and rear of tank.

12. DOORS — All-steel doors are flanged on all sides, are well reinforced. In spite of their lightness in weight they have many times the required strength. Rubber bumpers are provided for doors when open.

13. MISCELLANEOUS — Tanks are sandblasted and prime painted. U-bolts for attaching tank to chassis are included. These tanks are 10′ long (plus rear beaver tail) and can be mounted on trucks having a cab to axle measurement of approximately 84″.

T-178

THE HEIL CO.

GENERAL OFFICES • MILWAUKEE 1, WISCONSIN

Market Reports

MIDWEST—Price ranges on three grades of gasoline in Midwest market were lowered Nov. 28, when refiner reported reducing his postings on 73-75 oct. from 6c to 5.7c, 5.25c to 5.1c on 60 oct. & below, and withdrew quotation of 5.625c on 63-66 oct.; new price ranges on the three products, respectively, are 5.7-6c, 5.1-5.25c, and flat price of 5.5c. Central Michigan refiner who lowered his posting to 5c on straight run gasoline Nov. 15, reported quoting 5.5c Nov. 29, changing range to 5.5-6c on the product. Two Midwest refiners reported lowering housebrand postings to 5.75c, and one reported reducing Ethyl quotation to 6.7c which fell within existing price ranges. Central Michigan refiner reported quoting 5.5-6c on straight run gasoline; price range was unaffected.

Midwestern marketer reported open spot sales of nine cars range oil at 4c and two cars No. 2 fuel at 3.625c, f.o.b. Group 3. Another marketer in same area reported open spot sales of four cars range oil at 4.062c and four cars No. 2 fuel at 3.75c, and still another reported open spot sales totaling six cars, of 73-75 oct. at 5.25c, 78-80 oct. Ethyl at 6c, No. 2 fuel at 3.625c, and range oil at 4c, all f.o.b. Group 3.

* * *

CALIFORNIA—The weakened gasoline market persisted in the independent companies with inventories building up as the refinery runs slowed down. The major companies continued to attract sales. Quoted prices were unchanged.

MIDCONTINENT—East Texas refiner lowered his quotation on 42-44 kerosine 0.375c making the range now 4-4.5c. Nov. 30, refiner who was quoting low of range on 78-80 oct. Ethyl and 73-75 oct. gasoline increased his quotations 0.125c for both products. New range of 6.5-6.75c for Ethyl and 5.75-6c for housebrand succeeds previous range of 6.375c-6.75c and 5.625-6c for the two products, respectively, which existed on and since Nov. 21. Balance Midcontinent market unchanged. Gasoline demand throughout Oklahoma, Kansas, Texas and Arkansas remained "good" throughout week. Oklhoma refiner reported No. 2 moving heavily. Kerosine demand reported "very brisk" with scarcity of materials, especially in Group 3 area. Six cars, Grade 26-70 natural gasoline were reported sold at 4.5c f.o.b. Group 3; sellers quoted 4.5c. A total of 10 cars were reported sold at 3.5c f.o.b. Breckenridge; seller quoted 3.75c throughout the week.

* * *

PENNSYLVANIA — Despite the increasing shortage of kerosine, a lower field refiner re-entered the open spot market posting the 6.425c ceiling for that product. A lower field refiner reported sale of 5 tank cars No. 2 fuel oil at 5.875c.

Refiners generally reported a strong demand for kerosine from regular trade. Although calls from Eastern suppliers have thus far been limited, they said, demands from the East are expected to be "stepped up" as supplies become increasingly tight in that area. It was reported pipeline companies have notified refiners crude oil runs through the pipelines will be cut, hence an even tighter supply of bright and cylinder stocks is expected this winter.

* * *

GULF COAST — The flat price for gasoline, 70 oct., leaded, cargoes, was eliminated when only refiner posting withdrew his quotation. Other ranges were unaffected when a refiner re-entered the cargo market posting the 6.75c ceiling for premium gasoline and 4c for diesel oil, 43-47.

All materials continue extremely tight with no indication of softening in the market. Kerosine stocks are reported practically unavailable while calls from the East continue to "pour in".

* * *

ATLANTIC COAST — All residual prices were revised downward, effective Nov. 28, when suppliers reported their new prices in conformance with OPA Amendment 37 to MPR 88. The cut was made as a result of the recent lowering of tanker rates. No. 5 fuel oil at New York Harbor is now posted at $1.59-1.69 (low is for semi-refined), No. 6 fuel and bunker "C" fuel is being offered at $1.51. Only one supplier in Boston has not as yet reported his new quotations.

Kerosine continues in a critically short supply at all points. One marketer in New York reported shipping most of his material north in order to get product up to New England before transportation is halted. "That," he said, "leaves me with practically no inventory on hand." Other suppliers said that the residual situation is rapidly getting worse and predicted an acute shortage this winter.

Summary of Daily Gasoline Prices (November 26 to December 3)

	Monday Dec. 3	Friday Nov. 30	Thursday Nov. 29	Wednesday Nov. 28	Tuesday Nov. 27
U. S. Motor (ASTM octane)					
78-80 octane Ethyl:					
Oklahoma	6.5 – 6.75	6.375–6.5 (a)	6.5–6.75 (a)	6.5–6.75 (a)	6.5–6.75 (a)
Mid-Western (Group 3 basis)	6.625– 6.75	6.625– 6.75	6.625– 6.75	6.625– 6.75	6.625 –6.75
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 – 7.125	7 – 7.125	7 – 7.125	7 – 7.125	7 – 7.125
E. Tex. (Truck Tnsp.)	7	7	7	7	7
73-75 octane:					
Oklahoma	5.75 – 6	5.75 – 6	5.625–6 (a)	5.625–6 (a)	5.625–6 (a)
Mid-Western (Group 3 basis)	5.7 – 6	5.7 – 6	5.7 – 6	5.7 – 6	5.875– 6
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
E. Tex. (Truck Tnsp.)	6	6	6	6	6
63-66 octane:					
Oklahoma	5.375 (1)	5.375 (1)	5.375 (1)	5.375 (1)	5.375 (1)
Mid-Western (Group 3 basis)	5.5 (1)	5.5 (1)	5.5 (1)	5.5 (1)	5.5–5.625 (2)
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)
E. Tex. (Truck Tnsp.)	....	....	....	....	....
60 octane & below:					
Oklahoma	5.125– 5.25	5.125– 5.25	5.125– 5.25	5.125– 5.25	5.125– 5.25
Mid-Western (Group 3 basis)	5.1 – 5.25	5.1 – 5.25	5.1 – 5.25	5.1 – 5.25	5.125– 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
E. Tex. (Truck Tnsp.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline, 73-75 oct.					
New York harbor	8	8	8	8	8
New York harbor, barges	7.9	7.9	7.9	7.9	7.9
Philadelphia district	8	8	8	8	8
Baltimore district	7.75	7.75	7.75	7.75	7.75
Motor Gasoline, 70-72 oct.					
New York harbor	.....	....	....	....	....
New York harbor barges	.....	....	....	....	....
Philadelphia district	.....	....	....	....	....
Baltimore district	.....	....	....	....	....
Motor Gasoline:					
Western Penna. Bradford-Warren:					
(a) "Q" Gasoline, Min. 74 Oct. (ASTM)	7.50–7.75	7.50 – 7.75	7.50 – 7.75	7.50 – 7.75	7.50 – 7.75
Western Penna. Other Districts:					
"Q" Gasoline, Min. 74 Oct. (ASTM)	7 –7.25	7 – 7.25	7 – 7.25	7 – 7.25	7 – 7.25
70 oct. (ASTM)	....	....	....	....	....

Note: Gasoline prices are as reported in each day's Platt's OILGRAM. Daily Oil Price Service.
(a) Effective on and since Nov. 21, 1945.

OIL PRICE SECTION

★

At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from **Platt's** *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all *NPN-OILGRAM* offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

For complete price service delivered daily from nearest *OILGRAM* publishing office, New York, Cleveland and Tulsa, address Platt's Price Service, Inc., 1213 W. 3rd St., Cleveland (13), Ohio. Annual subscription rate payable in advance $100 per year train mail and $112.50 per year air mail.

Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified.

Prices in Effect	Dec. 3	Nov. 26
OKLAHOMA		
78-80 oct. Ethyl.	6.5 – 6.75	6.5–6.75 (a)
73 75 oct.	5.75 – 6	5.75–6 (a)
63-66 oct.	5.375 (1)	5.375 (1)
60 oct. & below.	5.125– 5.25	5.125– 5.25
MID-WESTERN (Group 3 basis)		
78-80 oct. Ethyl.	6.625– 6.75	6.625– 6.75
73-75 oct.	5.75 – 6	5.75 – 6
3-66 oct.	5.5 (1)	5.5–5.625 (2)
60 oct. & below.	5.1 – 5.25	5.125– 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
78-80 oct. Ethyl	?	?
73-75 oct.	6	6
63-66 oct.	5.625 (1)	5.625 (1)
60 oct. & below.	5.2 – 5.25	5.2 – 5.25
W. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
78-80 oct. Ethyl	7 – 7.125	7 – 7.125
73-75 oct.	6	6
63-66 oct.	5.625 (2)	5.625 (2)
60 oct. & below.	5.25	5.25
E. TEX. (Truck Tnspt.)		
78-80 oct.	?	?
73-75 oct.	6	6
63-66 oct.	....	....
60 oct. & below.	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
78-80 oct.	7 (2)	7 (2)
73-75 oct.	6 (2)	6 (2)
67-69 oct.	....	....
60 oct. & below.	5.25 (2)	5.25 (2)
KANSAS (For Kansas destinations only)		
78-80 oct. Ethyl.	7.1375–7.3	7.1375–7.3
73-75 oct.	6.2 – 6.3	6.2 – 6.3
63-66 oct.	5.9 (2)	5.9 (2)
60 oct. & below.	5.4375–5.5	5.4375–5.5
ARK. (For shipment to Ark. & La.)		
78-80 oct. Ethyl	7 (1)	7 (1)
73-75 oct.	6 (1)	6 (1)
62 oct.	....	....
60 oct. & below, unleaded	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline Min. 74 Oct. (ASTM)	7.50–7.75	7.50 – 7.75
Other districts:		
"Q" Gasoline. Min. 74 oct. (ASTM)	7 –7.25	7 – 7.25
70 oct. (ASTM)	....	....

(a) Effective Nov. 21, 1945.

Prices in Effect	Dec. 3	Nov. 26
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis; for shpt. within Mich. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
73-75 oct.	7.75 – 8.125	7.75 – 8.125
78-80 oct.	9–9.25 (2)	9–9.25 (2)
Str. run gasoline, excluding Detroit shpt.	5.5 – 6	5 – 6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
73-75 oct.	8.375	8.375
CALIFORNIA U.S. Motor:		
80-82 oct. (Ethyl).	8 – 8.5	8 – 8.5
74-75 oct.	7 – 7.5	7 – 7.5

Kerosine, & Gas Fuel Oils

OKLAHOMA		
41-43 grav. w.w.	4.25–4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range oil	4	4
No. 1 p.w.	3.875	3.875
No. 1 straw	3.75 (1)	3.75 (1)
No. 2 straw	3.625	3.625
No. 3 fuel	3.5	3.5
No. 6 fuel	$0.90–$0.97	$0.90–$0.97
U. G. I. Gas Oil	.....	.....
14-16 fuel	$0.97 (1)	$0.97 (1)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range Oil	4 –4.1	4 –4.1
No. 1 p.w.	3.875	3.875
No. 2 straw	3.625	3.625
No. 3	3.5(1)	3.5 (1)
No. 5	....	....
No. 6	$0.97 (1)	$0.97 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5 (1)	4.5 (1)
No. 1 p.w.	3.875 (1)	3.875 (1)
No. 6 fuel	$0.97 (1)	$0.97 (1)
W. TEX.		
No. 6 fuel	$0.97 (1)	$0.97 (1)
E. TEX. (Truck Tnspt.)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4 – 4.5	4 – 4.5
Range Oil	3.875–4 (2)	3.875– 4 (2)
No. 1 p.w.	3.875 (1)	3.875 (1)
45 Cet. Diesel	4.25 (1)	4.25 (1)
No. 2 straw	3.5–3.625 (2)	3.5–3.625 (2)
No. 3 fuel	....	....
58 D.I. & above	4.25 (1)	4.25 (1)
No. 6 fuel	$0.80–0.97	$0.80–0.97
U.G.I. gas oil	3.5 (1)	3.5 (1)
14-16 grav	....	....
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w.	4.5 (1)	4.5 (1)
KANSAS (For Kansas destinations only).		
41-43 grav. w.w.	No Price	No Price
42-44 grav. w.w.	4.7	4.7
No. 1 p.w.	4.1	4.1
No. 6 fuel	$1.02	$1.02
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w.	....	....
42-44 w.w. kero	4.5 (1)	4.5 (1)
No. 1	....	....
No. 2	3.625 (1)	3.625 (1)
No. 3 fuel	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only	5.125 (1)	5.125 (1)
Diesel fuel 52 & below	4 (1)	4 (1)
Diesel fuel 58 & above	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.	6.125– 6.55	6.125– 6.55
46 grav. w.w.	....	....
No. 1 fuel	6.5 (1)	6.5 (1)
No. 2 "	5.875– 6.125	5.875– 6.125
No. 3 "	5.875 (1)	5.875 (1)
36-40 gravity	6.25 (2)	6.25 (2)
Other districts:		
45 grav. w.w.	6.425	6.425
46 grav. w.w.	....	....
47 grav. w.w.	6.55 (2)	6.55 (2)
No. 1 fuel	6.175– 6.425	6.175– 6.425
No. 2 "	5.75 – 5.875	5.75 – 5.875
No. 3 "	5.75 – 5.875	5.75 – 5.875
36-40 grav Pittsburgh dist. prices excluded	5.75 – 5.875	5.75 – 5.875

Prices in Effect	Dec. 3	Nov. 26
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
46-49 gravity w.w.	5.8 – 6	5.8 – 6
P.W. Distillate	5.5	5.5
No. 3 gas, oil, Straw	5	5
U.G.I. gas oil	4.5	4.5
Fuel Oils (*Vis. at* 100).		
300-500 Vis.	4.14	4.14
100-300 Vis.	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine	?	?
CALIFORNIA		
40-43 grav. w.w.	7(1)	7(1)
San Joaquin Valley:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (1)	$1.20 (1)
Diesel fuel	4 (2)	4 (2)
Stove dist.	5 (2)	5 (2)
Los Angeles:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (1)	$1.20 (1)
Diesel fuel	3.25 – 4 (2)	3.25 – 4 (2)
Stove dist.	5 (1)	5 (1)
San Francisco:		
Heavy fuel	$1.15 (1)	$1.15 (1)
Light fuel	$1.25 (1)	$1.25 (1)
Diesel fuel	4.5 (1)	4.5 (1)
Stove dist.	5.5 (1)	5.5 (1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel oils, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	Dec. 3	Nov. 26
WESTERN PENNA.		
Prices are for sales made, or offers reliably ported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.	38 (1)	38 (1)
10 p.t.	37 (1)	37 (1)
15 p.t.	36 (1)	36 (1)
25 p.t.	28–33	28–33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.	36 (1)	36 (1)
10 p.t.	35 (1)	35 (1)
15 p.t.	34 (1)	34 (1)
25 p.t.	26–31	26–31
NOTE: Limited quantity neutrals available to regular trade.		
Cylinder Stocks: *Brt. stk.*, 145-155 *vis. at* 210°, 540-550 fl., *No. 3 col.*		
10 p.t.	30.5 (1)	30.5 (1)
15 p.t.	29.5 (1)	29.5 (1)
25 p.t.	25	25
600 S.R. filterable	15	15
650 S.R.	15.5	15.5
600 fl.	16	16
630 fl.	17	17
MID-CONTINENT (F. o. b. Tulsa)		
Neutral Oils (*Vis. at* 100° *F. 0 to* 10 *P.P.*		
Pale Oils:		
Vis. Color		
60-85—No. 2	7.5	7.5
86-110—No. 2	7.5	7.5
150—No. 3	11 –11.5	11 –11.5
180—No. 3	11.5 –15	11.5 –15
200—No. 3	12 –15	12 –15
250—No. 3	14 –16.5	14 –16.5
280—No. 3	15	15
300—No. 3	16 (2)	16(2)
Red Oils:		
180—No. 5	11.5 (1)	11.5 (1)
200—No. 5	12 (1)	12 (1)
280—No. 5	....	....
300—No. 5	16–17.5 (2)	16–17.5 (2)
Bright Stock—*Vis. at* 210°		
200 Vis. D	27 (1)	27 (1)
150-160 Vis. D: 0 to 10 p.p.	23	23
10 to 25 p.p.	22.5–23	22.5–23
25 to 40 p.p.	23 (1)	23 (1)
150-160 Vis. E	22 (1)	22 (1)
120 Vis. D: 0 to 10 p.p.	22 (2)	22 (2)
600 S.R. Dark Green	8.5 (1)	8.5 (1)
600 S.R. Olive Green	10-11 (2)	10-11 (2)
631 S.R.	....	....
Black Oil	....	....
SOUTH TEXAS (Neutral Oils)		
Pale Oils (*Vis. at* 100°*F.*)		
Vis. Color		
100 No. 1½-2½	6.5	6.5
200 No. 2-3	8.75	8.75
300 No. 2-3	9.25	9.25
500 No. 2½-3½	10	10
750 No. 3-4	10.25	10.25
1200 No. 3-4	10.375	10.375
2000 No. 4	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown, below reported in market leads.

Refinery Prices—Continued

Prices in Effect	Dec. 3	Nov. 26
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
2000 No. 5-6	10.5	10.5
CHICAGO (From Mid-Continent p.l. crude). Neutral oils *vis. at* 100° *F. 0 to* 10 *p.p.*		
Pale Oils		
Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)
Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.		
Unfiltered Steam Refined (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* 210 *No.* 8 *color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)
Note: To obtain prices delivered in Chicago add 0.25c per gal.		

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.)

FOB GROUP 3		
Grade 26-70	4.5 (Sales)	4.5 (Sales)
FOB BRECKENRIDGE		
Grade 26-70	3.5 (Sale)	3.5 (Sale)
CALIFORNIA (FOB plants in Los Angeles basin)		
21 pound vapor pressure for blending	4.75 (1)	4.75 (1)

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 – 7.125	7.1 – 7.125
Mineral spirits	6.1 – 6.125	6.1 – 6.125
Rubber solvent	7.1 – 7.125	7.1 – 7.125
Lacquer diluent	7.375– 8.125	7.375– 8.125
Benzol Diluent	7.875– 8.625	7.875– 8.625
WESTERN PENNA.		
Other Districts:		
Untreated naphtha	7-7.725 (2)	7 –7.725 (2)
Stoddard solvent	7.25 – 7.5	7.25 – 7.5
OHIO (S. O. quotations for statewide delivery:)		
	V.M.&P. naphtha.	D.C. naphtha, Varnolene &
Sohio solvent	10	10
Rubber solvent	9	9
E. TEXAS (Truck Tnspt.)		
Stoddard Solvent.	7 (2)	7 (2)

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25
MID-CONTINENT (C.L. FOB Refinery)		
Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5.25 (1)	5.25 (1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose, 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars, 0.5c per lb. less.)

Snow White	6.125– 7.25	6.125– 7.25
Lily White	5.375– 6.25	5.375– 6.25
Cream White	4.375– 5.5	4.375– 5.5
Light Amber	3.375– 4	3.375– 4
Amber	3.125– 3.75	3.125– 3.75
Red	3 – 3.5	3 – 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include taxes**; *they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include 1.5c federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect Dec. 3, 1945 as posted by principal marketing companies at their headquarters offices, but subject to later correction.*

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Philadelphia, Pa.	9	9.5	5.5	10.75
Pittsburgh	9.5	10	5.5	11.1
Allentown	9.5	10	5.5	11.1
Erie	9.5	10	5.5	11.1
Scranton	9.5	10	5.5	11.1
Altoona	9.5	10	5.5	11.1
Emporium	9.5	10	5.5	11.1
Indiana	9.5	10	5.5	11.1
Uniontown	9.5	10	5.5	11.1
Harrisburg	9.5	10	5.5	11.1
Williamsport	9.5	10	5.5	11.1
Dover, Del.	...	10	5.5	11.1
Wilmington, Del.	...	9.5	5.5	10.6
Boston, Mass.	...	9.7	4.5	....
Springfield, Mass.	...	10.6	4.5	....
Worcester, Mass.	...	10.3	4.5	....
Fall River, Mass.	...	9.8	4.5	....
Hartford, Conn.	...	10.4	4.5	....
New Haven, Conn	...	9.8	4.5	....
Providence, R. I.	...	9.8	4.5	....
Atlantic City, N. J.	...	9.5	4.5	8.5
Camden, N. J.	...	9.5	4.5	8.5
Trenton, N. J.	...	9.5	4.5	8.5
Annapolis, Md.	...	9.85	5.5	9.3
Baltimore, Md.	...	9.25	5.5	8.3
Hagerstown, Md.	...	10.35	5.5	8.8
Richmond, Va.	...	10.05	6.5	10.8
Wilmington, N. C.	...	10.35	7.5	10.4
Brunswick, Ga.	...	9.5	7.5	*9.6
Jacksonville, Fla.	...	9.5	8.5	10.6

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

FUEL OILS—T.W.

	1	2	3	5	6
Phila., Pa.	8.6	7.5	7.5	5.24	4.53
Allentown, Pa.	9.1	7.8	7.8	....	....
Wilmington, Del.	8.6	7.5	7.5	....	....
Springfield, Mass.	....	7.9	7.9	....	....
Worcester, Mass.	....	7.9	7.9	....	....
Hartford, Conn.	....	7.7	7.7	....	....

*Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.

Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w. price on t.w. deliveries of 25 gals. or more at one time.

CONTL OIL

	Conoco N-tane (3rd Grade) †Tank	Demand Wagon	Gasoline Taxes	Kerosine T.W.
Denver, Col.	10	9	5.5	10
Grand Junc., Col.	12.5	11.5	5.5	12.5
Pueblo, Col.	9.5	8.5	5.5	9.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	10	9	5.5	9
Billings, Mont.	12	11	6.5	12.5
Butte, Mont.	11.5	10.5	6.5	13.5
Great Falls, Mont.	12	11	6.5	12.5
Helena, Mont.	12	11	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Twin Falls, Ida.	14.5	13.5	7.5	17
Albuquerque, N. M.	10.5	9.5	*7	9.5
Roswell, N. M.	10	9	*7	7
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9	6.25	8	8
Texarkana, Ark.	9	7.5	*5.5	7
Muskogee, Okla.	7.75	6.75	9	8
Oklahoma City, Okla.	8	7	9	8
Tulsa, Okla.	8	7	9	8

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.

†To consumers & Dealers.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*)

	Thriftane Humble *Tank Wagon	Thriftane Humble Retail	(*Third Grade*) Thriftane *Tank Wagon	Thriftane Retail	Gasoline Taxes
Dallas, Tex.	*7.5	10.5	*6.5	8.5	5.5
Ft. Worth, Tex.	*7.5	10.5	*6.5	8.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

*Consumer tankwagon prices 1c per gallon above dealer tankwagon prices on Humble Gasoline, and Thriftane.

	Kerosine *Tank Wagon	Kerosine Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

*To all classes of dealers & consumers.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	Kerosine T.W.
Hamilton, Ont.	16.5	11	18
Toronto, Ont.	16.5	11	18
Brandon, Man.	20.5	10	22.5
Winnipeg, Man.	20.0	10	22
Regina, Sask.	17.5	11	19.5
Saskatoon, Sask.	20.3	11	22.3
Edmonton, Alta.	18.4	10	20.4
Calgary, Alta.	15.5	10	17.5
Vancouver, B. C.	15	10	24
Montreal, Que.	16.5	11	17.5
St. John, N. B.	16	13	19
Halifax, N. S.	16	13	19

*Includes 3c Federal, and Provincial taxes.
†To divided & undivided dealers.

SOCONY VACUUM

Socony Mobilgas (*Regular Grade*)

	Com. Dons. T.W.	Undiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	8.9	9.4	*5.5
Kings & Queens	8.9	9.4	*5.5
Richmond	8.5	9.0	*5.5
Albany, N. Y.	8.7	9.2	5.5
Binghamton, N. Y.	9.8	10.3	5.5
Buffalo	9.0	9.5	5.5
Jamestown, N. Y.	9.2	9.7	5.5
Mt. Vernon, N. Y.	8.9	9.4	5.5
Plattsburg, N. Y.	9.8	10.3	5.5
Rochester, N. Y.	9.6	10.1	5.5
Syracuse, N. Y.	9.3	9.8	5.5
Bridgeport, Conn.	8.8	9.3	4.5
Danbury, Conn.	9.3	9.8	4.5
Hartford, Conn.	9.4	9.9	4.5
New Haven, Conn.	8.8	9.3	4.5
Bangor, Me.	9.5	10.0	5.5
Portland, Me.	9.1	9.6	5.5
Boston, Mass.	8.7	9.2	4.5
Concord, N. H.	10.2	10.7	5.5
Lancaster, N. H.	10.8	11.3	5.5
Manchester, N. H.	10.1	10.6	5.5
Providence, R. I.	8.8	9.3	4.5
Burlington, Vt.	9.7	10.2	5.5
Rutland, Vt.	9.8	10.3	5.5

	Mineral Spirits	V.M.&P.
Buffalo, N. Y.	10.9	12.1
New York City	11	12
Rochester, N. Y.	11.8	13.1
Syracuse, N. Y.	12.2	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W.	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	6.0	8.8	....	7.8	5.6	7.5
Kings & Queens	6.0	8.8	....	7.8	5.6	7.5
Richmond	6.0	8.8	....	....	5.6	7.5
Albany	6.0	8.3	5.3	7.8	5.5	7.5
Binghamton	7.4	9.7	....	9.2	6.9	8.7
Buffalo	7.1	9.4	6.5	8.8	6.7	8.5
Jamestown	7.2	9.5	....	9.1	6.8	8.5
Mt. Vernon	6.1	8.8	....	7.9	5.7	7.5
Plattsburg.	6.6	8.9	....	8.4	6.1	7.9
Rochester.	7.2	9.5	6.4	8.7	6.4	8.2
Syracuse	7.0	9.3	6.3	8.6	6.3	8.1
Conn.:						
Bridgeport.	6.3	8.8	....	8.0	5.8	7.5
Danbury	6.7	9.3	....	....	6.3	7.0
Hartford	6.5	9.0	....	8.0	5.9	7.7
New Haven	5.8	8.8	5.5	7.8	5.4	7.5
Maine:						
Bangor	6.4	8.8	5.9	8.2	5.9	7.6
Portland	6.0	8.7	5.3	7.8	5.5	7.5

(Continued on next page)

Tank Wagon Prices—Continued

	Kero-sine		Mobil-fuel Diesel		Mobil-heat Fuel	
	Yard	T.W.	T.C.	T.W.	Yard	T.W.
Mass.:						
Boston	6.3	9.1	5.3	7.8	5.7	7.6
N. H.:						
Concord	6.9	9.2	....	9.0	6.7	8.5
Lancaster	8.0	10.3	....	10.0	7.7	9.5
Manchester	6.5	8.8	....	8.7	6.0	7.9
R. I.:						
Providence	6.3	8.8	5.3	7.8	6.7	7.6
Vermont:						
Burlington	6.6	8.9	6.0	8.3	6.0	7.7
Rutland	6.8	9.1	....	8.5	6.2	8.0

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

S. O. CAL.

	Stand-ard Reg. T.T.	Flight 3rd Grade T.T.	Chev-ron Av. 73 T.T.	Gaso-line Taxes	Kero-sine T.T.
San Francisco, Cal.	10	9	12.5	4.5	11.5
Los Angeles, Cal.	9.5	8.5	12	4.5	10
Fresno, Cal.	11	10	13.5	4.5	12.5
Phoenix, Ariz.	12	10	14.5	6.5	12.5
Reno, Nev.	12	11	14.5	5.5	13.5
Portland, Ore.	10.5	9.5	13	6.5	13.5
Seattle, Wash.	10.5	9.5	13	6.5	13.5
Spokane, Wash.	12.5	11.5	16	6.5	16.5
Tacoma, Wash.	10.5	9.5	13	6.5	13.5
Boise, Ida.	13.5	12.5	18	7.5	16.5

Resale and Commercial Gasoline: Tank car deliveries of Chevron Aviation 73, Standard's Supreme and Flight Gasoline .25c per gal. below posted net tank truck price. Tank car deliveries of Standard Gasoline .375c per gal. below posted net tank truck price. Pearl Oil (The Standard Kerosene) Tank car deliveries 3c below posted tank truck price.

S. O. IND.

	Red Crown Blue Crown Red Dealer Prices		(*Regular Grade*) (*Third Grade*)		
	Crown Cons. T.W.	Red Crown	Blue Crown	Gaso-line Taxes	Kero-sine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	...	4.5	10.0
Grand Rapids, Mich.	11.4	9.9	...	4.5	9.9
Saginaw, Mich.	11.4	9.9	...	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	....	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	5.5	10.1
Mason City, Ia.	11.7	10.2	9.7	5.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	....	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11.0
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0
Omaha, Neb.	11.4	9.6	9.4	6.5	10.1

Stanavo Ethyl Aviation Number 73

Kansas City, Mo.	13.5●●	*4.5
Fargo, N. D.	15.4●●	5.5
Huron, S. D.	14.8●●	5.5

●●Effective Oct. 20, 1945

	Oleum Spirits	V.M.&P. Naphtha	Stani-sol	*Taxes
	(Prices are base prices before discounts)			
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minnep'ls	14.2	15.2	13.5	5.5

Fuel Oils T.W.

	Chicago Standard Heater Oil	Stanolex Furnace Oil
1-99 gals.	9.3	8.8
100-149 gals.	8.3	7.8
150 gals. & over	7.8	...
150-399 gals.	...	7.8
400 gals. & over	...	7.3

	Stanolex Fuel A	Stanolex Fuel C
1-749 gals.	6.5	5.7
750 gals. & over	5.75	4.95

Stanolex Furnace Oil

Other Points	1-99 gals.	100 gals. & over
Indianapolis	9.0	8.0
Detroit	8.7	7.7
Milwaukee	9.0	8.0
Minneapolis	9.1	8.1
St. Louis	8.4	7.4
Kansas City	8.1	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 4c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

S. O. KY.

Crown Gasoline (*Regular*)

	†Crown-Gaso-line	Gaso-line Taxes	Kero-sine T.W.
Covington, Ky.	9.5	6.5	9.3
Lexington, Ky.	10.5	6.5	9.3
Louisville, Ky.	10	6.5	8.8
Paducah, Ky.	10	6.5	8.8
Jackson, Miss.	10	7.5	*9.0
Vicksburg, Miss.	9.5	7.5	*8.5
Birmingham, Ala.	10	*8.5	9.0
Mobile, Ala.	9	*9.5	8.5
Montgomery, Ala.	10	*9.5	*10.0
Atlanta, Ga.	10.5	7.5	*10.6
Augusta, Ga.	10.5	7.5	*10.1
Macon, Ga.	10.5	7.5	*10.6
Savannah, Ga.	9.5	7.5	*9.6
Jacksonville, Fla.	9.5	8.5	8.6
Miami, Fla.	9.5	8.5	8.6
Pensacola, Fla.	9	*9.5	8.0
Tampa, Fla.	9.5	8.5	8.6

NOTICE

These prices include inspection fee on both gasoline and kerosine unless otherwise specified per gallon as follows: Ala. 1/40c on gasoline; Florida 1/8c.

Kerosine inspection fee only: Ala. 1/2c.

S. O. N. J.

Esso (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
Atlantic City, N. J.	9.0	9.5	4.5	8.5
Newark	9.0	9.5	4.5	8.5
Annapolis, Md.	9.35	9.85	5.5	...
Baltimore	8.75	9.25	5.5	9.3
Cumberland	10.15	10.65	5.5	10.8
Washington, D. C.	9.0	9.5	4.5	9.8
Danville, Va.	10.45	10.95	6.5	10.05
Petersburg	9.55	10.05	6.5	10.8
Norfolk	9.25	9.75	6.5	9.8
Richmond	9.55	10.05	6.5	10.8
Roanoke	10.75	11.25	6.5	10.3
Charleston, W. Va.	11.05	11.55	6.5	12.1
Parkersburg	10.35	10.85	6.5	11.8
Wheeling	10.35	10.85	6.5	12.4
Charlotte, N. C.	10.9	11.4	7.5	9.1
Hickory	11.45	11.95	7.5	10.1
Mt. Airy	11.3	11.8	7.5	9.3
Raleigh	10.65	11.15	7.5	10.1
Salisbury	10.95	11.45	7.5	10.5
Charleston, S. C.	9.75	10.25	7.5	....
Columbia	10.6	11.1	7.5	....
Spartanburg	11.3	11.8	7.5	....
New Orleans, La.	8.75	9.25	8.5	**8.0
Baton Rouge	8.75	9.25	8.5	**8.5
Alexandria	8.75	9.25	8.5	**8.5
Lake Charles	9.0	9.5	8.5	**10.0
Shreveport	8.5	9.0	8.5	**7.0
Knoxville, Tenn.	10.5	11.0	8.5	10.5
Memphis	8.9	9.4	8.5	10.5
Chattanooga	10.5	11.0	8.5	9.0
Nashville	10.5	11.0	8.5	8.0
Bristol	9.75	10.25	8.5	10.0
Little Rock, Ark.	9.5	10.0	8.0	10.0
New Iberia, La.	9	9.5	8.5	**8

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2
Atlantic City, N. J.	8.5	7.5
Newark	8.5	7.5
Baltimore, Md.	8.3	7.5
Washington, D. C.	8.8	7.9
Norfolk, Va.	8.5	7.3
Petersburg	8.8	7.5
Richmond	8.8	7.5
Charlotte, N. C.	9.1	8.9
Hickory	...	8.5
Raleigh	10.1	8.6
Charleston, S. C.	...	7.5
Columbia	...	8.5
Spartanburg	...	9.3

Discounts:

**Includes 1.0c per gallon State Tax.

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey, Virginia, Tennessee and Louisiana.

Naphtha—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less; 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Miss. 1/50c; Neb. 3/100c; Nev. 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c; and Wisc. 3/100c.

Kerosine inspection fees only: Ala. 1/2c; Fla. 1/8c; Iowa 3/50c; Mich. 1/5c per gal.

S. O. OHIO

***Sohio X-70 Gasoline (*Regular Grade*)**

	Con-sumer T.W.	**Re-sel-lers	°S.S.	Gaso-line Taxes	†Ker-sine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Canton	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Lima	12	9.5	12.5	5.5	9.3
Mansfield	12	9.5	12.5	5.5	9.3
Marion	12	9.0	12.0	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3
Zanesville	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer Gasoline T.W.	Taxes
Sohio Aviation Gasoline Clear	14.5	5.5
Spec. AN-F-22, Amend. 1	15.5	5.5
Esso Ethyl Avia. Grade 73	16.5	5.5
Esso (Clear) Avia. Grade 80	17.5	5.5
Esso Aviation Grade 91/98	20.5	5.5
Esso Aviation Grade 100/130		

	Naphtha—T.W. Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	•8.3	•8.3	•7.8	•7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

°Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers. 2c off consumer t.w.

*For Cleveland area only. Full compartment hose dumps.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gaso-line Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

Seaboard Export Coastwise Prices

Atlantic Coast

(Prices are of refiners, FOB their refineries and their tanker terminals, and of tanker terminal operators FOB their terminals)—Prices in Effect December 3.

District	MOTOR GASOLINE 70-72 Oct. (ASTM)	73-75 Oct. (ASTM)	KEROSINE and/or NO. 1 FUEL	FUEL OILS No. 2	No. 3	No. 5	No. 6
N. Y. Harb.	....	8	5.6	5.2	5.2	$1.59-1.69(a)(b)	$1.51 (b)
N. Y. Harb., barges	....	7.9	5.5	5.1	5.1	....	....
Albany	....	8.1	5.8	5.3	5.3	....	$1.71 (1)
Philadelphia	....	8	5.7	5.2	5.2	$1.72 (b)	$1.51 (b
Baltimore	....	7.75	5.7	5.2	5.2 (2)	$1.59 (1)	$1.51 (2)
Norfolk	....	7.5	5.6	5.2	....	$1.55 (1)	$1.47
Wilmington, N. C.	....	7.5	5.55	5.2	....	....	....
Charleston	....	7.5	5.7	5.2	....	$1.50 (1)	$1.42 (2)
Savannah	....	7.37 – 7.375	5.55	4.75 (2)	....	....	$1.42 (1)
Jacksonville	....	7.37 – 7.375	5.55	4.75	....	....	$1.42
Miami	....	7.37 – 7.375	5.55	4.75 (2)	....	....	....
Tampa	....	7.37 – 7.375	5.55	4.75	....	....	$1.32
Pensacola	....	7 (2)	4.8 (1)	....	....	....	....
Mobile	....	6.75 – 6.87	4.75 (2)	....	....	....	....
New Orleans	....	6.25	4.125– 4.25	3.75 (2)	....	$1.05 (1)	$0.97
Portland	....	8.3	5.8	5.3	5.3 (1)	....	$1.555
Boston	....	8.2	5.7	5.3	5.3 (1)	$1.735-1.775 (2)	$1.555–1.595
Providence	....	8.2	5.7	5.3	5.3 (1)	$1.635	$1.525
New Haven	....	....	....	....	....	....	$1.525

(a) $1.59 semi-refined. (b) Effective Nov. 28, 1945.

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
New Haven	$1.525 (1)	....	....	....
N. Y. Harbor	$1.51–$1.55	$2.15	5.2	5.3 (2)
Albany	$1.71 (1)	$2.31 (1)	5.3 (1)	5.5 (1)
Philadelphia	$1.51–$1.55	$2.15	....	....
Baltimore	$1.51 (2)	$2.15 (2)	5.2 (1)	....
Norfolk	$1.47	$2.15 (2)	5.2 (1)	....
Charleston	$1.42 (2)	$2.15 (2)	5.2 (1)	....
Savannah	$1.42 (1)	....	....	....
Jacksonville	$1.42 (b)	$1.99 (1)	....	....
Tampa	$1.32	....	....	....
New Orleans	$0.97	$1.65 (1)	4 (1)	....
Portland	$1.555	....	5.3 (1)	5.3 (1)
Boston	$1.555	$2.19 (1)	5.3 (2)	5.3 –5.4 (2)
Providence	$1.525	$2.192 (2)	5.3 (1)	5.3 –5.4 (2)

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag; freight or export differentials).

Prices in Effect Dec. 3

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25 (1)	....	4.25 (1)
122-4 White	....	4.25 (2)	4.25(2)
124-6 White	4.25 (1)	4.25	4.25
Fully Refined:			
123-5	5.2 (1)	5.2 (2)	5.2 (1)
125-7	5.2 (1)	5.2 (2)	5.2 (2)
128-30	5.6 (1)	5.6	5.6 (1)
130-32	5.85 (1)	5.85 (2)	5.85 (1)
133-5	6.15 (1)	6.15	6.15 (2)
135-7	6.4 (1)	6.4 (1)	6.4 (1)

Naphtha

Prices in Effect Dec. 3

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

Gulf Coast

Prices in Effect Dec. 3

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	Barges	Texas Gulf Coast South of New Orleans Tank Cars	Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
78-80 oct.	6.75	6.5	6.75	6.75	6.75
73-75 oct.	6 – 6.25	5.75	5.75-6.5 (a)	5.75	5.75
70 oct.	....	....	....	....	....
80 oct. gasoline Research 2cc lead max.	....	....	....	....	6
Unleaded 70 oct.	....	....	....	....	5.625
67-68 oct.	....	....	....	....	....
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125– 4.25	4.125	4.125– 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 – 4	3.75	3.75
DIESEL & GAS OILS (In diesel index No.)					
No. 5 fuel oil	$1.05	....	$1.05	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	....	4.125	4.125	4.125
58 and above	4.25	....	4.25	....	4.25

(a) 5.75c for Dist. 1 and 6.25-6.50 for other districts.
NOTE: Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

HEAVY FUELS & BUNKER OIL (all Gulf Ports) Heavy Diesels	In Cargoes	In Ship's Bunkers (Ex Lighterage)
Below 28 API Grav.	....	$1.35
28 & above API Grav.	....	$1.65
Bunker C Oil	$0.97	$0.97

TANKER RATES

Approximate rates, cents per bbl.; Gulf-N. Atlantic, not east of New York

Heavy crude & fuel, 10-19.9 grav.	43.8
Light crude, 30 grav. or lighter	39
Gasoline	32.9
Kerosine	36
No. 2 fuel	38

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals).

Prices in Effect Dec. 3

Bright Stock *D color, Vis at 210°*	Steel Drums	Bulk
200 vis.	....	....
150 vis., 0-10 p.p.	32.65 (1&a)	24.8 (1)
100 vis., 0-10 p.p.	....	....
100 vis. 10-25 p.p.	....	....
Neutral—No. 3 color		
200 vis., 0-10 p.p.	....	....

(A) FAS at New Orleans.

Export Prices

Effective Dec. 3

	Mexican Gulf Ports U. S. Dollars per Bbl. Bunker C	Diesel
Tampico	$0.97	$1.65
Veracruz	0.97	....
Coatzacoalcos	0.97	1.65
	Pacific Coast	
Guaymas	$1.50	$3.22
Mazatlan	1.50	3.22
Acapulco	1.50	2.89
Manzanillo	1.50	2.89
Salina Cruz	1.50	2.89

NPN Gasoline Index

	Dealer T.W.	Tank Car
	Cents Per Gal.	
Dec. 3	9.96	6.54
Month ago	9.96	6.60
Year ago	10.38	6.72

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Pacific Exports *In Ship's Bunkers, or deep tank lots:*

Prices in Effect	Dec. 3	Nov. 26
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

REFINERY OPERATIONS

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Average Crude Runs to Stills Week Ended		Gasoline Production at Refineries inc. Natural Blended Week Ended		Kerosine Production Week Ended		Gas Oil & Dist. Fuel Oil Production Week Ended		Residual Fuel Oil Production Week Ended		Total Stocks Kerosine Week Ended	
	Nov. 24	Nov. 17	Nov. 24	Nov. 17	Nov. 24	Nov. 17	Nov. 24	Nov. 17	Nov. 24	Nov. 17	Nov. 24	Nov. 17
East Coast	796	825	2,063	2,098	258	278	1,058	943	1,768	1,779	5,134	4,844
Appalachian (Dist. 1)	100	101	382	375	49	54	85	74	70	56	417	409
Appalachian (Dist. 2)	56	52	199	147	21	8	38	33	93	80	36	26
Ind., Ill., Ky.	742	758	2,816	2,859	274	256	629	685	974	936	2,557	2,540
Okla., Kans., Mo.	339	340	1,378	1,330	149	127	307	330	443	435	928	950
Inland Texas	222	221	1,027	987	80	84	97	99	430	387	302	301
Texas Gulf Coast	1,141	1,172	3,964	4,053	613	574	1,396	1,404	1,707	1,682	1,813	1,909
Louisiana Gulf Coast	274	284	807	823	222	281	517	392	444	312	1,072	1,201
No. La. & Arkansas	56	62	178	189	35	28	63	66	101	107	214	459
Rocky Mt. (Dist. 3)	13	12	37	33	6	6	11	10	30	29	20	20
Rocky Mt. (Dist. 4)	104	101	391	403	19	18	81	87	212	224	109	110
California	805	765	2,439	2,280	99	97	520	463	2,528	2,487	421	412
Total U. S.—B. of M. Basis	4,648	4,693	15,681	15,577	1,825	1,811	4,802	4,586	8,800	8,514	13,023	13,181
U. S.—B. of M. Basis, Nov. 25, 1944	4,709	4,598	14,765	14,793	1,474	1,498	4,491	4,425	9,200	9,047	13,601	14,211

Districts	Total Stocks Gas Oil and Distillates Week Ended		Total Stocks Residual Fuel Oil Week Ended		Gasoline Stocks—*Military and Other** Week Ended		Gasoline Stocks—Civilian Grade Week Ended	
	Nov. 17	Nov. 10	Nov. 17	Nov. 10	Nov. 17	Nov. 10	Nov. 17	Nov. 10
East Coast	16,150	15,972	8,015	6,897	5,353	5,190	12,621	12,789
Appalachian (Dist. 1)	639	603	192	174	827	818	1,743	1,646
Appalachian (Dist. 2)	130	124	205	208	81	110	728	652
Ind., Ill., Ky	6,516	6,505	3,269	3,184	3,747	3,884	13,098	12,743
Okla., Kans., Mo.	2,855	2,922	1,147	1,133	1,129	1,197	6,352	5,911
Inland Texas	442	463	1,031	1,004	1,023	1,060	1,813	1,745
Texas Gulf Coast	5,980	6,271	4,922	5,230	5,148	5,213	9,113	8,367
Louisiana Gulf Coast	2,020	1,786	1,650	1,452	1,028	943	2,493	2 536
N. La. & Arkansas	523	500	363	381	13	19	1,717	1,447
Rocky Mt. (Dist. 3)	19	20	32	30	15	15	89	87
Rocky Mt. (Dist. 4)	527	527	712	743	304	314	1,279	1,209
California	9,457	9,648	24,936	25,172	6,980	7,125	6,490	5,934
Total U. S.—B. of M. Basis	45,258	45,341	46,474	45,608	25,648	25,888	57,536	55,066
U. S.—B. of M. Basis Nov. 25, 1944	46,513	47,209	63,047	63,465	38,841	39,223	40,870	39,437

*Includes aviation and military grades, finished and unfinished, title to which remains in the name of the producing company; solvents, naphthas, blending stocks currently indeterminate as to ultimate use, 8,027,000 bbl. unfinished this week, compared with 12,284,000 bbl. a year ago.

**These figures do not include any gasoline on which title has already passed, or which the military forces may have in their own or leased storage.

Percent Daily Refining Capacity Reporting—East Coast 99.5; Appalachian (Dist. 1) 76.8, (Dist. 2) 81.2; Ind., Ill., Ky., 87.2; Okla., Kans., Mo., 78.3; Inland Texas, 59.8; Texas Gulf Coast, 89.3; Louisiana Gulf Coast, 96.8; No. Louisiana & Arkansas, 55.9; Rocky Mt. (Dist. 3) 17.1; (Dist. 4) 72.1; California, 86.5; Total—U. S.—B. of M. Basis Nov. 24, 1945 85.7; Total—B. of M. Basis Nov. 17, 1945 85.7.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Nov. 24 Barrels (Daily Average)	Nov. 17 Barrels (Daily Average)
Oklahoma	°383,600	°388,700
Kansas	°260,200	°267,350
Nebraska	°750	°750
Texas	1,894,200	1,894,200
Louisiana	368,300	368,400
Arkansas	76,300	76,050
Mississippi	53,150	54,150
Alabama	550	550
Florida	100	150
Illinois	207,300	206,850
Indiana	13,400	13,350
Eastern (Ill., Ind. & Ky. excluded)	58,300	63,550
Kentucky	28,750	29,150
Michigan	46,300	45,850
Wyoming	97,250	97,300
Montana	19,500	19,500
Colorado	21,300	21,800
New Mexico	94,250	94,200
California	845,800	832,600
Total, U. S.	4,469,300	4,474,500

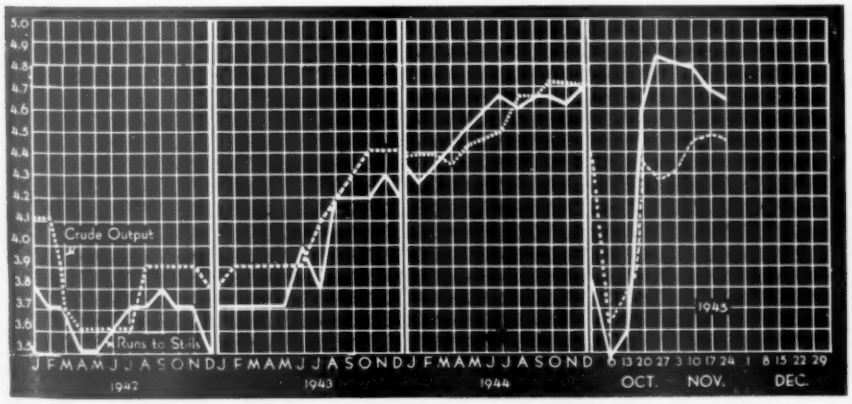
°Okla., Kans., Neb. figures are for week ended 7:00 a.m., Nov. 21, 1945.

Crude Oil Stocks

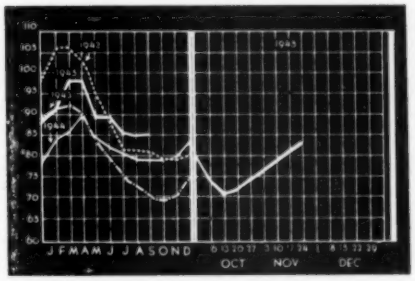
(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	Nov. 17	Nov. 24	Change from Nov. 17
Penna. Grade	2,155	2,089	— 66
Other Appalachian	1,628	1,501	—127
Lima-Michigan	1,027	1,007	— 20
Illinois-Indiana	15,075	15,000	— 75
Arkansas	2,477	2,427	— 50
Kansas	9,636	9,724	+ 88
Louisiana	13,605	13,698	+ 93
Northern	3,877	3,953	+ 76
Gulf Coast	9,728	9,745	+ 17
Mississippi	2,426	2,478	+ 52
New Mexico	5,775	5,757	— 18
Oklahoma	33,313	33,401	+ 88
Texas	106,613	105,465	—1,148
East Texas	17,418	17,320	— 98
West Texas	33,247	33,350	+103
Gulf Texas	30,154	29,553	—621
Other Texas	25,794	25,262	—532
Panhandle	4,200	4,332	+132
North	6,647	6,369	—278
South	5,997	5,721	—276
Other	8,950	8,840	—110
Rocky Mountain	6,716	6,844	+128
California	17,617	17,734	+117
Foreign	2,440	2,238	—202
Total gasoline-bearing in U. S.	220,503	219,363	—1,140
Heavy in California	4,464	4,656	+192

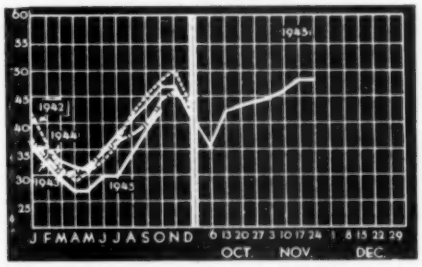
Crude Production & Runs to Stills *(Millions of Barrels)*



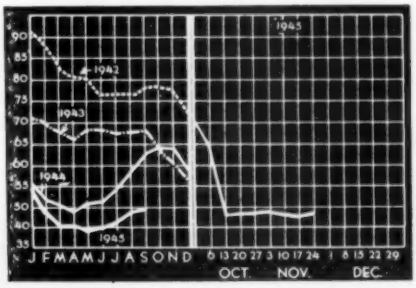
Gasoline Stocks *(Millions of Barrels)*



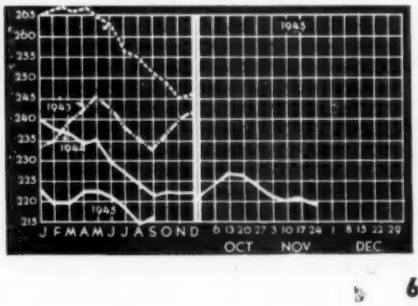
Gas Oil & Distillate Stocks *(Millions of Bbls.)*



Residual Fuel Oil Stocks *(Millions of Bbls.)*



Crude Oil Stocks *(Millions of Barrels)*



Pacific Coast Demand

(Bureau of Mines figures in thousands of bbls. daily)

	Gasoline		Gas Oil & Diesel		Heavy Fuel Oil		All Products	
	1944	1945	1944	1945	1944	1945	1944	1945
January	275	304	103	104	505	545	993	1,066
February	315	315	109	100	478	594	1,011	1,124
March	311	332	108	94	479	519	1,018	1,068
April	302	406	88	83	450	536	954	1,148
May	295	402	85	75	411	520	900	1,135
June	352	398	87	64	395	490	969	1,085
July	335	396	63	59	353	421	884	1,011
August	329	370	63	78	349	434	883	1,010
September	323	363	65	76	382	400	902	954
October	313	...	70	...	450	...	945	...
November	328	...	80	...	467	...	992	...
December	319	...	101	...	558	...	1,093	...
Jan.-Sept.	315	365	86	81	422	495	946	1,067

Mid-Continent Lube Statistics (August 1945)

(Compiled by Western Petroleum Refiners Assn. from reports of member companies. Figures in bbls. of 42 gal.)

	Bright Stock	Viscous Neutrals	Paraffin Oils	Steam Refined Stock	Blended Oils
Production	215,780	293,129	47,856	17,886	314,182
Shipments:					
Domestic	175,264	289,428	49,235	18,454	289,128
Export	5,509	1,318	33	156	7,359
TOTAL	180,773	290,746	49,268	18,610	296,487
Inventory Sept. 30, '45	176,233	169,179	57,646	39,726	137,487

Pennsylvania Lubricating Oils

(Compiled by National Petroleum Assn. from reports of companies refining Pennsylvania Grade crude oil. Figures in bbls.)

	Production Sept. 1945	Inventory Sept. 1945	Production Aug. 1945	Inventory Aug. 1945
Raw Long Residuum	43,314	33,110	51,272	36,704
600 Steam Refined Stock	237,355	73,853	236,500	83,744
Other Steam Refined Stock	38,691	34,643	55,849	44,923
Finished dewaxed Long Residuum	44,304	30,417	44,346	34,598
Bright Stock	149,766	181,002	190,801	174,744
Viscous Neutral (below 180 Vis.)	56,088	136,553	56,438	128,892
Viscous Neutral (180 Vis. at 100)	86,866	114,312	92,912	122,756

Production of Natural 'Gas', Allied Products

	Sept., 1945	Aug., 1945
East Coast	...	...
W. New York	...	...
W. Pennsylvania	831	821
West Virginia	5,135	5,530
Ohio	467	337
Illinois	12,677	15,085
Kentucky	1,272	3,664
Michigan	1,159	1,203
Kansas	6,114	5,892
Oklahoma	34,199	35,011
Texas:	169,573	183,460
Gulf	41,517	44,884
East Texas	29,702	34,405
Panhandle	44,002	41,717
Other	54,352	62,454
Arkansas	6,185	7,026
Louisiana	27,316	45,768
Gulf	20,722	27,810
Inland	6,594	17,958
New Mexico	8,747	9,319
Colorado	*	*
Montana	357	295
Wyoming	*3,603	*4,224
California	72,192	77,612
Total	349,827	395,247
Daily average	11,661	12,750
Total (thousands of bbls.)	8,329	9,411

*Wyoming includes Colorado drip gasoline.

Dealer and Service Station Gasoline Prices in 50 Representative U. S. Cities September, 1945

City	Dealers' Net Price (Ex. Tax)	Indicated Dealer Margin	Gasoline Tax (Inc. 1½ Cent Federal Tax)	Service Station (Inc. Tax)
Portland, Me.	9.60	5.2	5.50	20.30
Manchester, N. H.	10.60	4.2	5.50	21.40
Burlington, Vt.	10.20	5.2	5.50	20.90
Boston, Mass.	9.20	5.2	4.50	18.90
Providence, R. I.	9.30	5.4	4.50	19.20
Hartford, Conn.	9.90	5.2	4.50	19.60
Buffalo, N. Y.	9.50	4.5	5.50	19.50
New York, N. Y.	9.40	6.6	5.50	21.50
Newark, N. J.	9.00	6.2	4.50	19.70
Philadelphia, Pa.	9.00	5.4	5.50	19.90
Dover, Del.	9.50	5.5	5.50	20.50
Baltimore, Md.	8.75	5.25	5.50	19.50
Washington, D. C.	9.00	5.2	4.50	18.70
Charleston, W. Va.	11.05	4.65	6.50	22.20
Norfolk, Va.	9.25	6.75	6.50	22.50
Charlotte, N. C.	10.90	4.8	7.50	23.20
Charleston, S. C.	9.75	4.55	7.50	22.80
Atlanta, Ga.	10.50	4.6	7.50	22.60
Jacksonville, Fla.	9.50	4.6	8.50	22.60
Birmingham, Ala.	10.00	5.0	8.50	*23.50
Vicksburg, Miss.	9.50	5.0	7.50	22.00
Memphis, Tenn.	8.90	4.5	8.50	21.90
Lexington, Ky.	10.50	3.5	6.50	20.50
Youngstown, Ohio	9.50	3.0	5.50	18.00
South Bend, Ind.	10.50	4.5	5.50	20.50
Chicago, Ill.	9.60	2.76	4.50	16.86
Detroit, Mich.	9.90	3.74	4.50	18.14
Milwaukee, Wisc.	10.60	4.3	5.50	20.40
Twin Cities, Minn.	10.40	4.5	5.50	20.40
Fargo, N. Dak.	11.40	4.0	5.50	20.90
Huron, S. Dak.	10.80	3.7	5.50	20.00
Omaha, Neb.	9.60	3.0	6.50	19.10
Des Moines, Ia.	9.90	3.5	5.50	18.90
St. Louis, Mo.	9.50	3.0	4.50	*17.00
Wichita, Kans.	8.80	3.7	4.50	16.50
Tulsa, Okla.	8.00	3.0	9.00	20.00
Little Rock, Ark.	9.50	4.5	8.00	22.00
New Orleans, La.	8.75	4.75	8.50	22.00
Houston, Texas	8.50	4.5	5.50	18.50
Albuquerque, N. Mex.	10.50	4.5	7.00	‡22.00
Denver, Colo.	10.00	4.0	5.50	19.50
Casper, Wyo.	11.50	5.5	5.50	22.00
Butte, Mont.	9.50	4.0	6.50	20.00
Boise, Ida.	13.50	4.0	7.50	25.00
Salt Lake City, Utah	13.50	4.5	5.50	23.50
Reno, Nev.	12.00	4.0	5.50	21.50
Phoenix, Ariz.	12.00	4.0	6.50	22.50
San Francisco, Calif.	10.00	4.0	4.50	18.50
Portland, Oreg.	10.50	4.0	6.50	21.00
Spokane, Wash.	12.50	4.0	6.50	23.00

* Includes City Tax of $1.00; ‡ Includes City Tax of 0.50.

Pennsylvania Oils Other Than Lubes At Refineries

(Compiled by National Petroleum Assn. from reports of oil region refiners. Figures in barrels.)

	Sept. 1945	Aug. 1945
Naphthas & Gasoline		
(1) Straight run, unblended and/or unleaded, for sale as motor fuel	2,540	2,953
(2) Naphtha and gasoline, for sale for blending or further refining, or held at refinery for further distillation, reforming, blending or leading	220,080	232,272
(3) Below 65 Octane, not included in (1) or (2) above	1,112	1,227
(4) 65 Octane and above	137,654	165,983
Salable Naphthas other than motor fuel material (does not include refinery process naphthas)	15,648	14,782
Kerosene	99,839	88,567
36/40 gas oil (include furnace oil)	72,339	55,552
Fuel oil (not reported above)	36,190	39,854
Oils held as cracking plant charging stocks	403,658	385,703
Non-viscous neutral	32,181	29,906
Wax distillate	86,276	91,594
Crude petrolatum	32,145	29,732
Wax (lbs.)	4,034,259	2,871,834

Net Stocks Of Pennsylvania Crude Oil

(Compiled by National Petroleum Assn. Figures in bbls.)

	Sept. 30, 1945	Aug. 31, 1945	Sept. 30, 1944
At Refineries	301,247	327,453	337,308
Pipeline and Tank Farm	1,449,065	1,472,998	1,521,006

CRUDE PRICES

Since changes in crude oil prices are few, the two pages of crude oil price tables are printed only when there are sufficient changes to warrant.

A record is kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers.

Crude Price Changes

No price changes reported for week ending Nov. 28.

For latest table of crude prices published, see NPN Nov. 28, pages 57 58 and 59.

Daily Av. Pennsylvania Crude Runs

(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

Week Ended Nov. 24, 1945	Week Ended Nov. 17, 1945	Week Ended Nov. 25, 1944
63,827	64,603	64,446

Ohio Oil Buys 3 Companies In Market Expansion Program

Special to NPN

FINDLAY, Ohio — The Ohio Oil Co. has taken another step forward in its planned program of expanding marketing facilities. This is represented by the recent acquisition of materially all the assets of the Producers Oil Co. Inc., and Producers Gas Market Inc., as well as real estate owned by the First Central Realty Co., including 23 service stations and five service station sites. All three of these companies have been controlled by the family of the late Bernard H. Ziehler, with general offices in Dayton, O.

Founded by Mr. Ziehler, the Producers Oil Co. and Producers Gas Market expanded under his management until they became one of the largest independent distributors of gasoline and petroleum products in Ohio and Indiana. Under their trade name of "King Benzol," petroleum products were dispensed at stations in the Ohio cities of Dayton, Springfield, Middletown, Miamisburg and Columbus, and in Indiana at Indianapolis, Anderson and Terre Haute.

Following the death of Mr. Ziehler in 1943, his two sons, Bernard A. and Robert J., continued to manage and operate the distribution outlets of the Producers Oil Co. until its purchase by The Ohio Oil Co. in November.

Under the ownership of the Ohio Oil Co., the stations comprising this important deal will continue in operation as Marathon Service Stations. Thorough renovation and general overhauling of each station, its furnishings and equipment, is now under way.

Pittsburgh Meter Stockholders Vote Change in Company Name

Special to NPN

PITTSBURGH — Stockholders of Pittsburgh Equitable Meter Co. Nov. 30 approved a recommendation of the directors changing the name of the company to Rockwell Manufacturing Co. At the same time it was voted to split the stock on a four-for-one basis.

Approval of the stock issue authorizes that 500,000 shares of common stock be increased to 4,000,000 shares. The present shares now outstanding on the four-for-one split would be increased proportionately.

GASOLINE CONSUMPTION BY STATES, AUGUST 1945

	Tax Rate* August Cents	Month of July, 1945 Gallons	Month of August, 1945 Gallons	Month of August, 1944 Gallons	Change %	8 Months Ending With August, 1945 Gallons	8 Months Ending With August, 1944 Gallons	Change %
Alabama	6	24,740,000	28,158,000	22,951,000	+22.69	194,019,000	171,032,000	+13.44
Arizona	5	10,021,000	10,854,000	9,723,000	+11.49	82,655,000	91,044,000	— 9.21
Arkansas	6½	18,171,000	21,610,000	15,640,000	+38.17	135,055,000	116,501,000	+15.93
California	3	238,983,000	263,765,000	210,025,000	+25.59	1,757,299,000	1,589,610,000	+10.55
Colorado	4	28,052,000	32,416,000	27,521,000	+17.79	200,993,000	201,450,000	— 0.23
Connecticut	3	26,024,000	28,565,000	24,300,000	+17.55	192,326,000	181,846,000	+ 5.76
Delaware	4	4,496,000	6,422,000	4,918,000	+30.58	35,297,000	34,100,000	+ 3.51
District of Columbia	3	9,120,000	10,640,000	9,396,000	+13.24	74,389,000	72,249,000	+ 2.97
Florida	7	32,474,000	35,441,000	29,600,000	+19.73	269,348,000	254,590,000	+ 5.80
Georgia	6	36,304,000	40,226,000	32,646,000	+23.22	273,700,000	247,963,000	+10.38
Idaho	6	10,165,000	11,851,000	10,527,000	+12.58	68,599,000	61,698,000	+11.18
Illinois	3	114,127,000	116,588,000	97,616,000	+19.44	819,131,000	781,989,000	+ 4.75
Indiana	4	70,818,000	67,784,000	60,692,000	+11.69	506,430,000	475,646,000	+ 6.47
Iowa	3	51,929,000	56,781,000	43,024,000	+31.98	393,877,000	362,157,000	+ 8.76
Kansas	3	58,331,000	54,429,000	45,462,000	+19.73	329,305,000	303,709,000	+ 8.43
Kentucky	5	32,261,000	34,753,000	24,948,000	+39.30	244,962,000	189,986,000	+28.94
Louisiana	7	27,603,000	32,649,000	26,073,000	+25.22	218,607,000	200,643,000	+ 8.95
Maine	4	14,167,000	15,331,000	13,433,000	+14.13	93,946,000	86,599,000	+ 8.48
Maryland	4	25,993,000	29,356,000	30,479,000	— 3.68	220,061,000	194,259,000	+13.28
Massachusetts	3	50,426,000	57,506,000	47,806,000	+20.29	382,206,000	351,791,000	+ 8.65
Michigan	3	100,500,000	115,173,000	100,234,000	+14.90	770,526,000	711,182,000	+ 8.34
Minnesota	4	48,165,000	54,741,000	44,290,000	+23.60	335,285,000	305,006,000	+ 9.93
Mississippi	6	21,236,000	20,839,000	20,092,000	+ 3.72	148,145,000	138,312,000	+ 7.11
Missouri	2	52,214,000	58,237,000	44,097,000	+32.06	370,496,000	345,561,000	+ 7.22
Montana	5	12,852,000	17,124,000	12,683,000	+35.02	88,142,000	78,549,000	+12.21
Nebraska	5	25,373,000	28,685,000	23,314,000	+23.04	173,412,000	156,885,000	+10.53
Nevada	4	4,557,000	4,835,000	8,069,000	—40.08	32,907,000	42,722,000	—22.97
New Hampshire	4	6,832,000	8,730,000	6,763,000	+29.08	47,755,000	43,625,000	+ 9.47
New Jersey	3	61,724,000	69,464,000	61,101,000	+13.69	482,730,000	458,708,000	+ 5.24
New Mexico	5	11,554,000	12,799,000	9,715,000	+31.74	82,449,000	73,310,000	+12.47
New York	4	128,923,000	144,138,000	126,637,000	+13.80	943,171,000	924,052,000	+ 2.07
North Carolina	6	39,461,000	40,520,000	28,844,000	+40.48	293,491,000	270,189,000	+ 8.63
North Dakota	4	17,455,000	25,205,000	21,547,000	+16.98	127,951,000	115,579,000	+10.70
Ohio	4	118,084,000	132,503,000	128,134,000	+ 3.41	932,852,000	922,205,000	+ 1.15
Oklahoma	7½	62,582,000	59,369,000	46,105,000	+28.77	411,940,000	301,291,000	+36.73
Oregon	5	25,247,000	28,841,000	25,339,000	+13.82	174,195,000	174,791,000	— 0.34
Pennsylvania	4	106,265,000	122,482,000	99,372,000	+23.26	794,840,000	750,460,000	+ 5.91
Rhode Island	3	10,292,000	12,587,000	11,589,000	+ 8.61	83,478,000	77,895,000	+ 7.17
South Carolina	6	18,825,000	21,051,000	17,242,000	+22.09	140,460,000	130,738,000	+ 7.44
South Dakota	4	14,900,000	18,124,000	15,195,000	+19.28	101,171,000	89,062,000	+13.60
Tennessee	7	33,285,000	30,989,000	30,738,000	+ 0.82	235,063,000	288,519,000	+ 2.86
Texas	4	401,857,000	429,257,000	383,176,000	+12.03	3,288,432,000	2,591,384,000	+26.90
Utah	4	10,842,000	12,729,000	9,997,000	+27.32	75,288,000	68,247,000	+10.32
Vermont	4	4,940,000	5,802,000	4,242,000	+36.77	33,182,000	28,872,000	+14.93
Virginia	5	36,856,000	44,869,000	41,210,000	+ 8.88	305,702,000	283,412,000	+ 7.87
Washington	5	35,493,000	42,100,000	35,259,000	+19.40	260,057,000	246,267,000	+ 5.60
West Virginia	5	16,516,000	17,034,000	11,248,000	+51.44	117,121,000	105,800,000	+10.70
Wisconsin	4	51,989,000	60,639,000	44,696,000	+35.67	368,802,000	320,605,000	+15.03
Wyoming	4	6,063,000	7,471,000	7,483,000	— 0.16	45,800,000	45,035,000	+ 1.70
Total		2,369,087,000	2,601,462,000	2,205,211,000		17,757,048,000	15,997,125,000	
Daily Average		76,422,000	83,918,000	71,136,000		73,074,000	65,562,000	
Change from previous year:								
Total Change		.....	+396,251,000	.....		+1,759,923,000	.....	
Percentage change in Daily Average		.....	+17.97%	.....		+11.46%	.....	

* These are State tax rates per gallon. In addition there is the Federal tax of One and one-half cents (1½c) per gallon.

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Welcome Back . . . . . .

And Other News About Oil Soldiers and Sailors

Maj. Walter T. Davis, after almost three years of Army service, is back in Louisville, Ky., as chief executive of Aetna Oil Co.

Maj. Davis, who became Aetna's president in 1941, and whose service with that company started in 1924 as a laboratory assistant, volunteered for Army service in 1942. He accepted a commission as a captain in the Chemical Warfare Service, and sailed for the China-Burma-India theater of operations in April, 1943.

Maj. Davis

After transfer to the Corps of Engineers, he was assigned to the Theater Staff Petroleum Section. There he became theater petroleum officer, the highest office in the Petroleum Section, after outstanding success as executive officer for the Petroleum Section, and deputy area petroleum officer.

He obtained his majority in August, 1944, and made an outstanding record in his activities in connection with American installations in India, Burma, and many of those in China. Upon his return to the United States, he was assigned to the Military Plans Section of the Fuels and Lubricants Division of the Quartermaster Corps, where he remained until relieved from active duty.

Maj. Davis, who joined Aetna in 1924 after receiving his B. S. degree from Massachusetts Institute of Technology, filled practically every position in the company before reaching the top.

° ° °

Lt. N. O. Staebler has left the Navy Fuel Organization to resume his activities as treasurer of the Staebler-Kempf Oil Co. and the Dixie Terminals Oil Co. at Ann Arbor, Mich.

Long-Term requirements officer in the Fuel Division's statistical section, he reported to the Bureau of Supplies and Accounts Jan. 24, 1944.

Wins Legion of Merit Award

Special to NPN

PONCA CITY, Okla. — Lieut Col. Robert W. Hird, an employe on leave from the sales promotion division of Continental Oil Co. has received the Army's Legion of Merit award for outstanding service in development of the famous "Weasel," officially known as Cargo Carrier M29C. He is the son of Capt. Willard F. Hird, division manager for Continental at Lincoln, Nebr., a veteran of World War I and also a veteran of 37 years' service in Conoco ranks.

Lieut. Co. Donald C. O'Hara, released from the Army on Nov. 15, has joined the staff of the National Petroleum Assn., **Fayette B. Dow**, general counsel, announced.

Col. O'Hara's first duties for N.P.A. will be in the field of industrial relations, a departmental activity recently inaugurated. His headquarters will be in Washington.

He entered the Army in May, 1941, as aide to Lieut. Gen. Edmund B. Gregory, the quartermaster general, with the additional duty of executive secretary of the QM Contract Adjustment Board. From January, 1943, to April, 1944, he was commanding officer of the U. S. Army Supply Depot at Belem, Brazil. From May, 1944, to date of his discharge he was executive officer, OQMG.

Graduated from Michigan State College in 1937, Col. O'Hara received his law degree from George Washington University in 1941. During his law school course he was employed by the government in the Federal Housing Administration, the Federal Bureau of Investigation and the Social Security Board.

° ° °

Dana Whitten, recently discharged from the Army Air Forces and Hans Winkler, just out of the United States Navy, have returned to the Sun Oil Co. and have been assigned to the West Texas-New Mexico district geological staff at Midland.

° ° °

Back with Standard Oil Co. (Ohio), with more important duties is **Maj. C. E. Spahr. Col. William C. Kinsolving,** supervisor of construction of the China-Burma-India pipeline between Calcutta and the India-Burma border, termed him "one of my mainstays, and a boy who has what it takes."

Maj. Spahr was called to active duty as a first lieutenant of engineers in May, 1941, and after serving in Oregon camps, at Camp Claiborne, Bringhurst, La., he was selected by the Army, because of his outstanding record as a pipeline engineer, for duty in connection with the building of Calcutta-Kunming pipeline. As a member of the staff in this theater, he had charge of construction of some 500 miles of pipeline. In 1945 he was transferred to the headquarters of C. B. I., where he was promoted to the rank of major.

Maj. Spahr, after graduating from the University of Kansas, was with Phillips Petroleum for a time. He was employed by Sohio as a senior pipeline engineer, in Oct., 1939.

At this time, Maj. Spahr is temporarily filling the position as manager of Sohio's Industrial Relations, supply and transportation department.

Maj. Hubert L. James, liaison officer with RFC in Washington for the Readjustment Division, ASF, expects to be back at his old desk in the sales department of James B. Berry Sons' Co., Oil City, Pa., shortly after Jan. 1 when he is to be discharged. He entered the service as a second lieutenant in February, 1942, reporting to the Raritan Arsenal, New Brunswick, N. J., to establish an Ordnance Petroleum Procurement Office there, and served under the direction, at the Washington level, of Lieut. Col. James A. Richardson, formerly of Shell Oil, and Maj. George Schoenbaum, formerly of Jersey Standard. Later, he represented Ordnance in the Fuels and Lubricants Division, OQMG.

Maj. James

° ° °

Lieut. J. H. B. Joiner, Jr., and **Lieut. D. E. Bodenschatz,** two naval officers with the Army-Navy Petroleum Purchase Agency, have just returned to civilian oil careers. Lieut. Joiner, again serving as vice president of Maritime Petroleum Corp., New York City, began his war service as a civilian employe of the Army Fuels and Lubes Division, OQMG, Dec. 22, 1943. He joined the military purchase agency as a naval lieutenant when it was organized, on June 23, 1945, and served as a buyer of fuel oil, gasoline and other oil products. Lieut. Bodenschatz, who also joined the oil purchase agency on that date, having entered the Navy in 1942, is returning to General Petroleum Corp., Los Angeles, where he will resume his duties as assistant manager of bulk fuel oil sales.

Ex-Point Loma Naval Fuel Depot Officer Back With Texas Co.

Special to NPN

SAN DIEGO, Calif.—Lieut. John Stone, formerly at the Naval Fuel Depot at Point Loma, an annex to the Naval Supply Depot here, has returned to the employ of The Texas Co. at Ft. Worth. Lieut. Stone began work for The Texas Co. in 1931 remaining there until 1943 when he entered the Navy. His last position with the company was as wholesale bulk plant manager. (See NPN, Oct. 10)

Pay Clerk Raymond Miller, also stationed at the same depot, reports from Japan, according to Com. H. E. Kemp, Point Loma officer in charge, that the bulk of his work there consists of fueling Jap ships employed in returning Nips from the various islands which they attempted to homestead.

Prior to entering the Navy Mr. Miller was with the Sun Oil Co., operating the plants bulk terminal at Gilford Park, N. J.

ABOUT OIL PEOPLE

George J. Spellman, Sinclair Refining, **L. E. Ashby,** Canfield Oil, **C. F. Belkofer,** Gulf Refining, **C. M. Dawson,** Socony-Vacuum, and **W. H. Loughran,** Sinclair Refining, all of Cleveland, are making plans for a Christmas party for the Petroleum Club of the Cleveland Chamber of Commerce, on Dec. 17 at the Statler Hotel.

The party will be preceded by an election of three club directorships for three-year terms. The nominating committee is composed of **A. F. Jordan,** U. S. Air Compressor Co.; Mr. Dawson, and **George E. Read,** Calumet Refining Co.

° ° °

A. D. Dubuisson, well known independent oil man who has been holding public office around the town of South Haven, Mich., for a good many years where he runs the Wolverine Service Stations, is again performing as a hunter. He has just returned from Beaver Island, Mich., where he reports having shot a 185-lb. deer, duly equipped with eight points.

The last time the writer saw Al he had just pulled in the biggest northern pike in the history of the particular bay where he had been fishing, also up in Michigan. But then maybe this isn't the biggest buck that has ever been shot in Michigan.

° ° °

Dr. Bailey Willis, professor emeritus of geology at Stanford University, was guest speaker before the Fort Worth Geological Society on "terrestrial dynamics". He appeared under the auspices of the distinguished lecture committee of the American Association of Petroleum Geologists. Dr. Willis, now 88, was twice decorated by King Leopold of Belgium and served as assistant director of the United States Geological Survey.

° ° °

Lloyd Jeter has joined the Midland, Tex., offices of the Amerada Petroleum Corp. as scout. He recently was released from the Army Air Forces.

° ° °

George Walmsley, who has been in charge of the power department at Baytown Refinery of the Humble Oil & Refining Co. for the past 15 years, has resigned. He left Humble to take up new duties with the general engineering department of the Standard Oil Development Co. at Bayway, N. J.

° ° °

Thomas S. Johnston, formerly associated with the Standard Oil Co. (N. J.) at New York, has been named manager of the marine departments of Imperial Oil, Ltd., and International Petroleum Co., Ltd., at Toronto, Canada. Mr. Johnston succeeds **H. J. Rahlves,** who is retiring from active service.

H. O. (Bud) Harder was appointed assistant general superintendent of production of Sunray Oil Corp., Dec. 1. He will be located in the Tulsa office as assistant to **Harry H. Mack,** vice president and general superintendent in charge of production.

Mr. Harder, a native Oklahoman, attended the University of Tulsa, and is a graduate of the University of Oklahoma. He comes to Sunray with 20 years production experience in the oil industry in the Midcontinent area.

° ° °

Dr. Chester R. Longwell, chairman of Yale University's Department of Geology, described the geology of basin ranges in Southern Nevada and Western Arizona in a lecture before the Dallas Geological Society. Sponsored by the American Association of Petroleum Geologists, the lecture was open to the public.

° ° °

Jack H. Abernathy, who resigned as assistant general production superintendent of Sunray Oil Corp. Nov. 16, has become vice president and manager of the Big Chief Drilling Co. of Delaware, with office in the First National Bank building, Oklahoma City. He will relieve **President William T. Payne** of many of the managerial and production duties he has been assuming.

Personnel of the reorganized Big Chief shows Mr. Payne as president; Mr. Abernathy as vice president and manager; **Sidney Hodges,** vice president in charge of drilling, and **F. E. Godfrey,** secretary and treasurer.

° ° °

Pei-Yeh-Wang, member of the petroleum engineering group from among the 1200 young men sent to America under the sponsorship of the central government of China and the international training administration, has been assigned duty and training with The Texas Co. at Electra, Tex. He was employed in the oil fields in Central China two years and says the drilling equipment used here is of the same type as that used before the war in China.

° ° °

Ted R. Spurling, former assistant superintendent of the Lone Star Gas Company's cycling plant at Grapeland, has been appointed superintendent of the company plant at Trinidad. He succeeds **W. A. Robinson** who has been named assistant superintendent of gasoline plants in Lone Star West Texas area.

° ° °

Reese H. Taylor, president, Union Oil Co. of California, has been re-elected a class B director of the Federal Reserve Bank of San Francisco for a term of three years.

E. J. Frueh, former director of supply and transportation for PAW Dist. 2 at Chicago, has joined Triangle Refineries at St. Louis, Mo. Mr. Frueh was with PAW from May 1, 1944, until Oct. 31, 1945, when the office closed. Prior to that time he was with the petroleum industry committee in Chicago, and before that was associated with Shell Oil Co., Inc., at St. Louis.

COMING MEETINGS

DECEMBER

Oil Dealers Assn. of Arkansas, Hotel Marion, Little Rock, Dec. 11.

Detroit Oil Men's Club, annual meeting, Carl's Bar & Chop House, Detroit, Dec. 11.

Wisconsin Petroleum Assn., Schroeder Hotel, Milwaukee, Wisc., Dec. 11-12.

Interstate Oil Compact Commission, Allis Hotel, Wichita, Kan., Dec. 13-15.

Mid-Continent Oil & Gas Assn., annual board of directors meeting. Tulsa, Club Roof Room, Tulsa Building, Tulsa, Dec. 18.

Western Oil and Gas Assn., annual business meeting and conference, Biltmore Hotel, San Francisco, Dec. 19.

Geological Society of America, 58th annual meeting at Hotel William Penn, Pittsburgh, Dec. 27-29.

JANUARY

Oil & Heat Institute of America board of directors, Commodore Hotel, New York, Jan. 8, 1946.

North Carolina Oil Jobbers Assn., Raleigh, N. C., Jan. 9, 1946.

Oil Trade Assn. of Philadelphia, 33rd annual banquet, Bellevue-Stratford Hotel , Philadelphia, Jan. 17.

Northwest Petroleum Assn., Jan. 24-25, Nicollet Hotel, Minneapolis, Minn.

Independent Natural Gas Assn., Houston, Jan. 28.

FEBRUARY

Petroleum Division of National Assn. of Credit Men, Congress Hotel, Chicago, Feb. 11-13.

Illinois Petroleum Marketers Assn. convention, Hotel Pere Marquette, Peoria, Ill., Feb. 12-14.

Kentucky Petroleum Marketers Assn. 20th annual meeting and trade exhibit Brown Hotel, Louisville, Ky., Feb. 19-20.

Missouri Independent Oil Jobbers Assn., Hotel Governor, Jefferson City, Mo., Feb. 19, 20.

Iowa Independent Oil Jobbers Assn., Hotel Ft. Des Moines, Des Moines, Feb. 26-27.

APRIL

Natural Gasoline Assn. of America, annual convention, Baker Hotel, Dallas, Texas, April 17-18-19, 1946.

National Petroleum Assn., Hotel Cleveland, Cleveland, O., April 18-19, 1946.

Oil & Heat Institute of America Industry Exhibition, Philadelphia, April 23-27, 1946.

MAY

National Association of Corrosion Engineers, President Hotel, Kansas City, May 7, 8, and 9.

National Oil Scouts & Landmen's Assn., Jackson, Miss., May 16-18, 1946.

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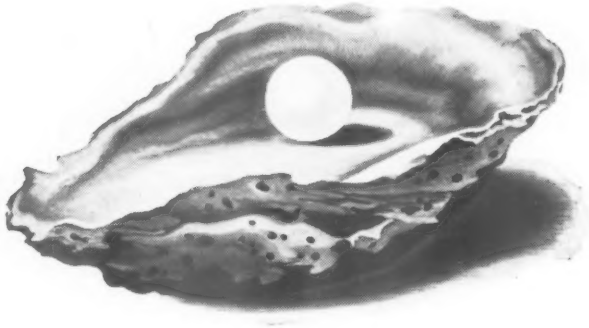

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TECHNOLOGY DEPT.

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to
REFINERY MANAGEMENT and PETROLEUM CHEMICAL TECHNOLOGY

Section Two | December 5, 1945 | Vol. 37, No. 49

How Aviation Gasoline Output Was Expanded Ten-Fold

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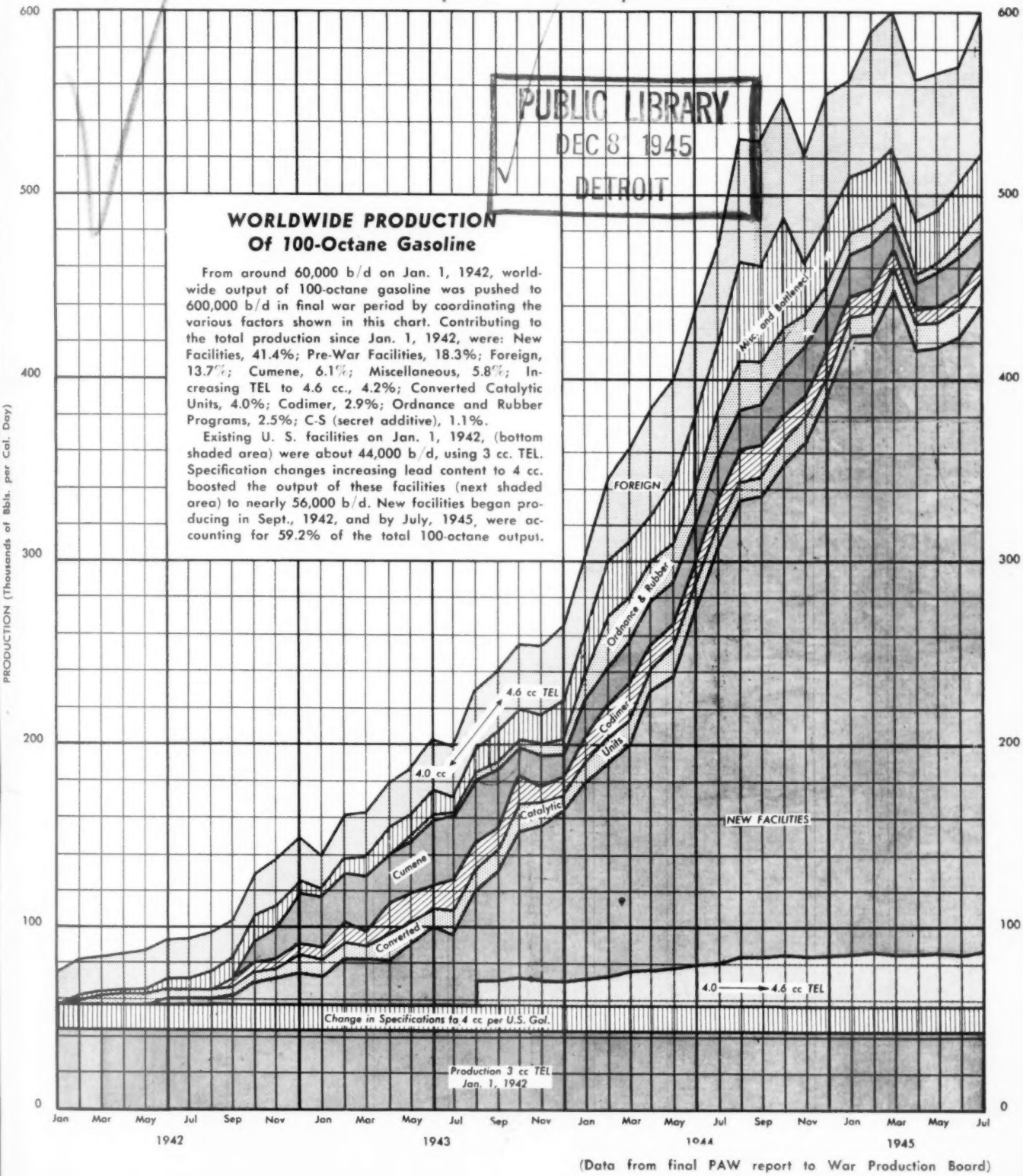
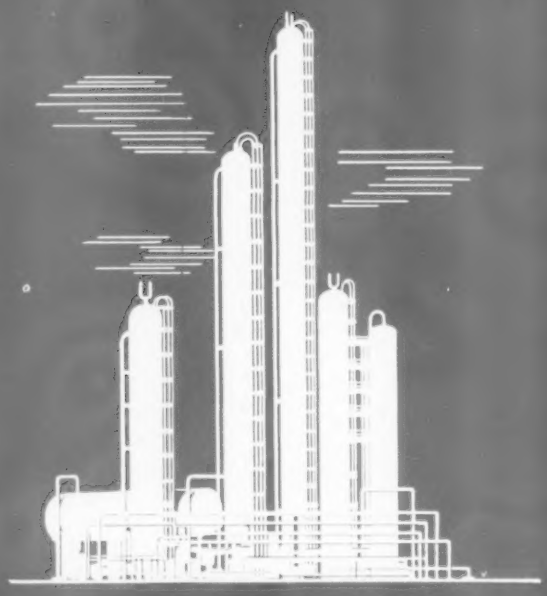
WORLDWIDE PRODUCTION Of 100-Octane Gasoline

From around 60,000 b/d on Jan. 1, 1942, worldwide output of 100-octane gasoline was pushed to 600,000 b/d in final war period by coordinating the various factors shown in this chart. Contributing to the total production since Jan. 1, 1942, were: New Facilities, 41.4%; Pre-War Facilities, 18.3%; Foreign, 13.7%; Cumene, 6.1%; Miscellaneous, 5.8%; Increasing TEL to 4.6 cc., 4.2%; Converted Catalytic Units, 4.0%; Codimer, 2.9%; Ordnance and Rubber Programs, 2.5%; C-S (secret additive), 1.1%.

Existing U. S. facilities on Jan. 1, 1942, (bottom shaded area) were about 44,000 b/d, using 3 cc. TEL. Specification changes increasing lead content to 4 cc. boosted the output of these facilities (next shaded area) to nearly 56,000 b/d. New facilities began producing in Sept., 1942, and by July, 1945, were accounting for 59.2% of the total 100-octane output.



(Data from final PAW report to War Production Board)



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PREVIEW

OF JANUARY FEATURES

Will Texas Become Center of Chemical Manufacture?

Wartime demands stimulated a movement started a few years previously to locate plants in Texas and adjoining states for the manufacture of chemical products from the natural gas and petroleum base materials available there in volume.

Now that wartime restrictions on plant information have been removed, D. P. Thornton, Jr., Assistant Editor of NPN's TECHNICAL SECTION has been through this territory, visiting some of these plants and interviewing the managers of others. He has written from firsthand data a roundup article on the petrochemical industry in the southwest. Exclusive in the January TECHNICAL SECTION.

Disposal of Refinery Wastes (First Article in New Series)

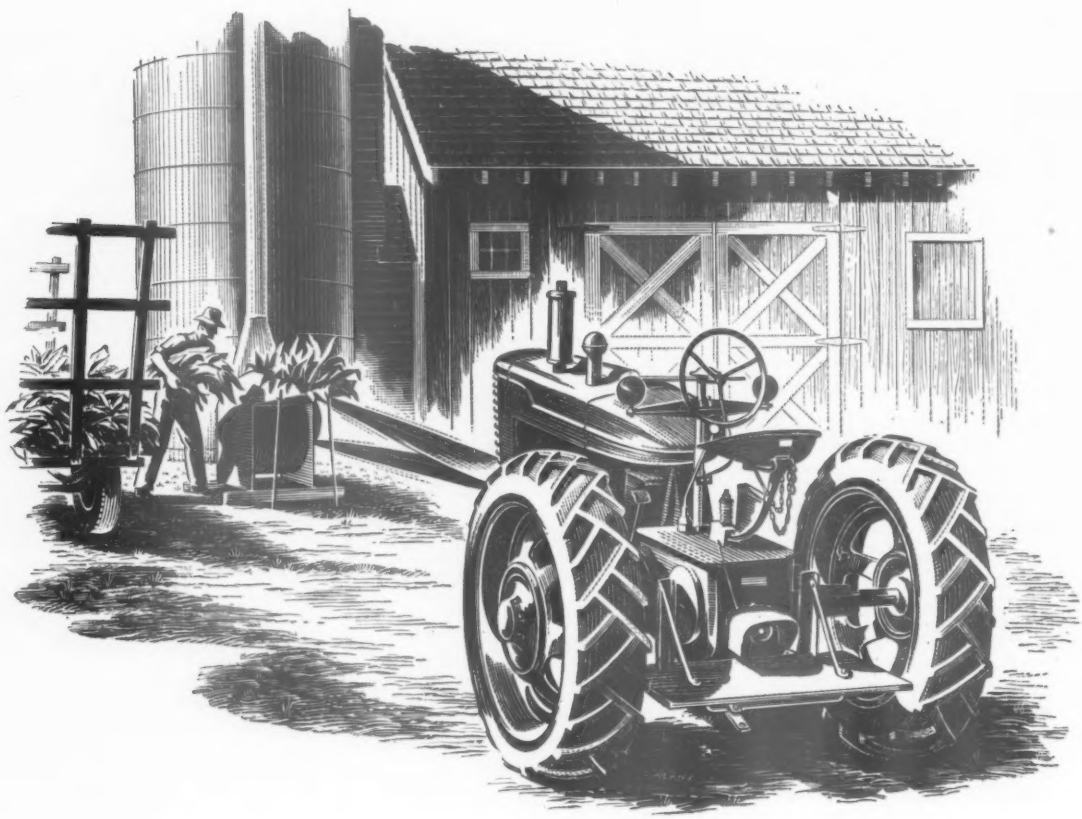
To acquaint plant operators with modern methods for the disposal of waste materials, including solids, liquids and gases, W. B. Hart, Atlantic Refining Co. technologist, has written several articles for the NPN TECHNICAL SECTION exclusively, presenting the results of his many years of practical experience and study in this field. The introductory article, among other topics, tells of the various conditions and factors that make the disposal of wastes a more important plant operating problem today than ever before.

TCC Principles Applied To Oil Shale Retorting

If the nation's vast reserves of oil shale are to become a potentially important source for synthetic liquid fuels, practicable methods must be developed for retorting the shale. With the experience gained in perfecting the TCC process, Engineers of Socony-Vacuum Oil Co., Inc., have developed a method for applying the same principles of heat exchange in continuous shale retorting. This method as worked out in the laboratory, with test data on operations and yields, is described in a special article prepared by members of this company's technical staff for the January TECHNICAL SECTION.

Economics of Peace-time Use of War-time Processes

While the problem of what war-time refining facilities can be operated economically in the present competitive period is one to be ultimately decided by the individual refiner, there are certain technical and economic considerations which apply generally. An authority in the industry presents the results of some competitive studies of alkylation, isomerization, catalytic cracking and other operations for motor gasoline production.



HORSES THAT DO THE CHORES—AS WELL AS PLOW

TIME was when a farmer was glad to have a team of good horses to do his work. Today, in his tractor, the American farmer has anywhere from ten to forty horsepower.

And these "horses" can do a lot more than pull a plow or other field rig. They can grind feed, fill silos, saw wood, lift hay, clean barns and do dozens of other jobs. The modern tractor is really a portable power plant.

But tractors haven't always been so versatile. Only a little more than a decade ago, tractors were generally powered by cumbersome, hard-to-start, slow-moving engines burning kerosene or other low-grade fuels. Then the high compression principle, already developed in automobile and airplane engines, was adopted by the farm machinery industry.

Engines were redesigned to take advantage of gasoline, and great increases in the power and flexibility of tractors resulted . . . giving the farmer a ready, convenient source of power at all times. In this evolution of the present compact, inexpensive tractor the Ethyl Corporation was privileged to play a unique part—though we neither manufacture tractor engines nor refine gasoline.

Our product is the antiknock fluid used by practically all petroleum refiners to improve the antiknock quality of their gasoline. Higher octane gasoline, in turn, permits the building of more efficient engines. In order that the ultimate user of power—in this instance, the farmer—may realize the greatest benefit from antiknock fluid, our research engineers work with both engine builders and petroleum refiners in finding answers to the many complex problems of engines, fuels and lubricants. The modern high compression tractor was a direct product of such cooperative work.

More power from every gallon of gasoline through

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REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

Dec. 5, 1945
Volume 37
Number 49

MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

NEW 1000 B/D CATALYTIC CRACKER OPERATES ON FLUID PRINCIPLE

Small scale catalytic operation on a basis economically comparable with two-coil thermal cracking is claimed by Universal Oil Products for its new M-S Type unit, details of which are given below.

The unit operates on the fluid catalyst principle and employs a microspherical catalyst. Construction economies have been achieved by combining the reactor and regenerator into a single unified column, by shortening the regenerator standpipe, and by eliminating the regenerator riser and all secondary catalyst recovery equipment.

Yields of 45.5 to 53% of 400° F. end point debutanized motor gasoline are achieved when processing Mid-Continent gas oil on a once-through operation at 65% conversion. Clear octane rating of the product is as high as 82.1 (ASTM motor method) and 93 (research method). Lead susceptibility is 5.6 to 6.3 points with 3 cc. of TEL.

A NEW small scale catalytic cracking unit with charge capacities of as low as 1000 b/d and operating on the fluid catalyst principle is now available for the small refiner.

Designed by engineers of Universal Oil Products Co. and revealed for the first time during the recent American Petroleum Institute meeting in Chicago, it is known as the "M-S Type" catalytic cracking unit. The name stems from the microspherical form of catalyst used.

Investment and operating costs per barrel of charge are said to compare favorably with two-coil thermal cracking operations of comparable charge capacity.

Much simpler in design and operation than the standard Fluid units of over 10,000 b/d charge capacity, the new M-S type catalytic cracking unit is reported to be entirely practical for the smaller refiner who is faced with the problem of increasing the octane rating of his motor gasoline.

Major modifications in the M-S type unit as compared to the Fluid cracking plant of earlier design are described by UOP engineers as follows:

1—The reactor and regenerator have been combined into a single vessel, erected as a self-supporting column. The heavy structure required in the earlier units has been eliminated.

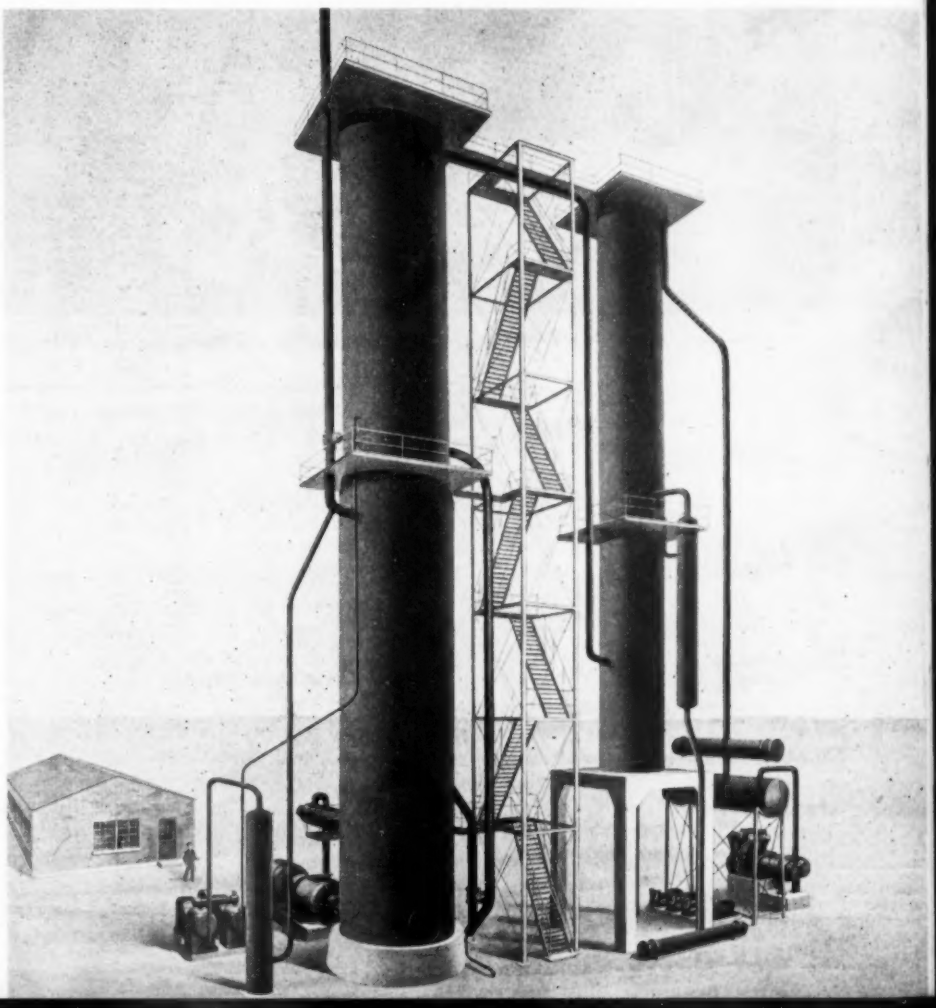
2—The large regenerator riser has been eliminated; the regenerator standpipe is greatly shortened.

3—All secondary catalyst recovery equipment, such as a Cottrell precipitator or an oil scrubber on the regenerating side, and a slurry settler or slurry recirculating system on the processing side, has been eliminated.

4—Additional distribution grids have been added in both the reactor and regeneration sections.

5—Air supplied for combustion passes through the regenerator countercurrent to the catalyst, permitting multi-stage stripping and more complete utilization of oxygen.

The first three of these factors are largely responsible for what UOP claims



Artist's sketch of the new small-capacity catalytic cracking unit

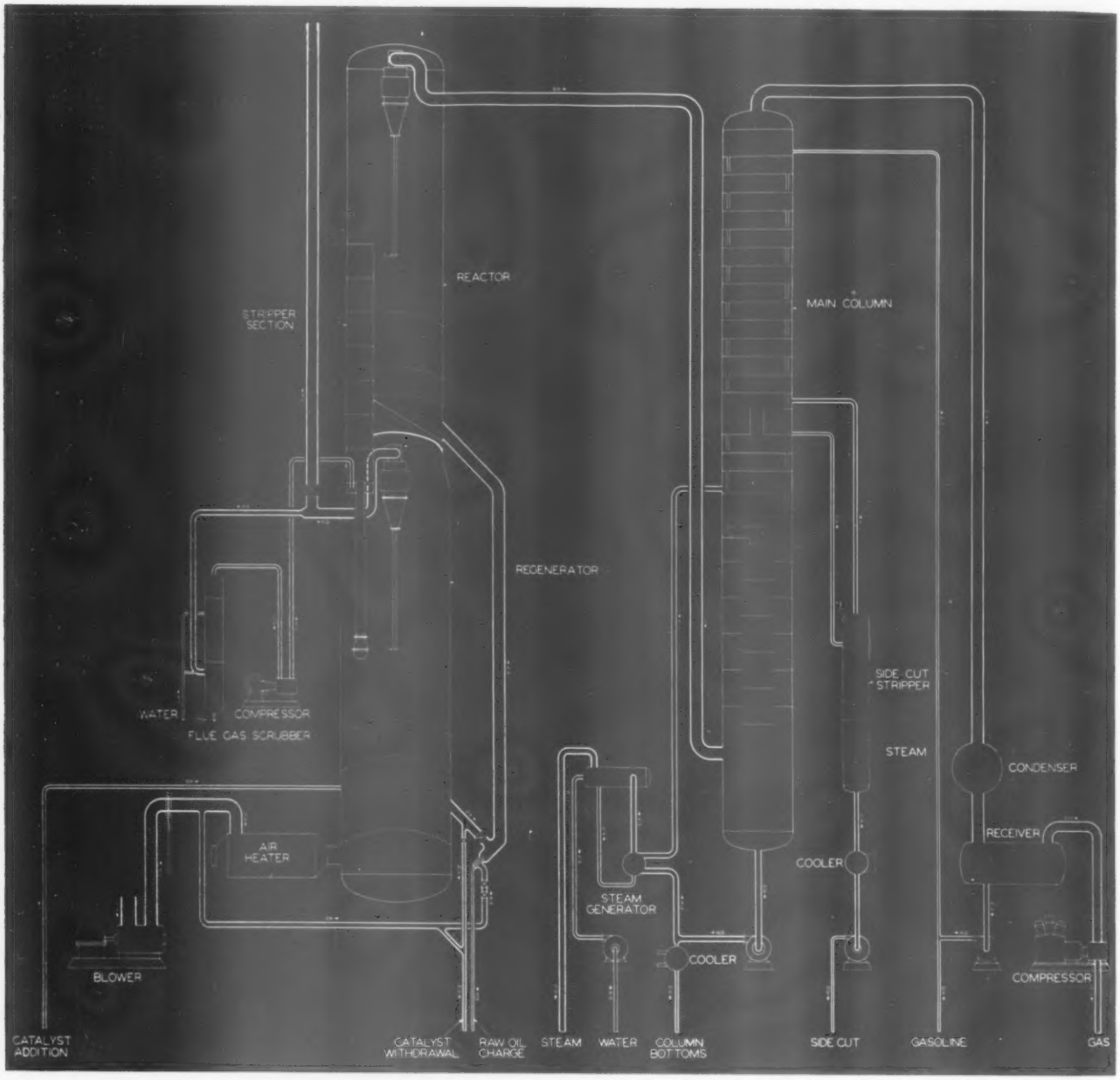


Fig. 1—Flow sheet for the M-S type catalyitc cracking unit

are marked reductions in investment cost as well as substantial decreases in operating, maintenance and utility requirements.

Height of the reactor-regenerator column in the smallest unit (1000 b/d) is less than 100 ft., and diameter is about 6 ft. Greater capacity is achieved by increasing the diameter of the column, rather than by going to a taller structure.

Increased Gasoline Yield Claimed

The improved reactor design, employing additional distribution grids, provides for better contacting of oil and catalyst, and, UOP engineers claim, has actually increased gasoline yield and decreased light gas and coke produced at any given conversion.

The new regenerator design providing for countercurrent contacting of catalyst

TABLE 1—Typical Yields and Product Qualities, Based on Processing Mid-Continent Gas Oil, Once-Through Operation at 65% Conversion

Catalyst	Silica-Magnesia	Natural	Silica-Alumina
Yields, Vol. %			
Debutanized 400°F. E P Gasoline	53.0	48.9	45.5
Cycle Stock, 400°F. +	35.0	35.0	35.0
Butylenes	5.5	5.8	6.2
Butanes	5.5	7.4	10.9
Propylene	3.8	4.8	6.8
Fropane	1.9	3.4	3.7
C_2 & Lighter Gas, Wt. %	1.9	1.7	1.7
Debutanized 400°F. E P Gasoline (5-6# R. V. P.)			
Octane No. ASTM (F-2)			
Clear	79.1	80.3	82.1
+3 cc. TEL	85.2	86.5	87.7
Octane No. Research (F-1)			
Clear	89.0	90.8	93.0
+3 cc. TEL	95.4	96.5	98.7
Cycle Stock, 400°F. +			
Gravity, °API	26	26	26
C_2 and Lighter Gas			
Molecular Weight	12	12	14
Heating Value, BTU/Cu. Ft.	740	740	840

TABLE 2—Production Summary for Once-Through Catalytic Cracking of Mid-Continent Gas Oil

Catalyst Form	Microspherical Silica-Magnesia			Powdered Natural			Microspherical Silica-Alumina		
Type Catalyst									
Charge, Bbls. per Calendar Day	900	2700	4500	900	2700	4500	900	2700	4500
Conversion, 100—Vol. % Cycle Oil	65	65	65	65	65	65	65	65	65
C_2 & Lighter, MCFCD	164	494	822	147	441	735	126	379	631
C_2 & Lighter, 10^6 Btu/CD	121	363	605	108	375	541	106	319	531
Propylene, BCD	36	108	180	43	129	215	61	183	305
Propane, BCD	17	51	85	31	92	153	34	101	168
Butylenes, BCD	50	150	250	52	156	260	56	168	280
Isobutane, BCD	39	117	195	54	161	268	82	246	410
N-Butane, BCD	10	30	50	13	40	67	16	48	80
Debutanized—400°F. EP Gasoline, BCD	477	1430	2385	440	1320	2200	409	1230	2045
Cycle Oil, BCD	315	945	1575	315	945	1575	315	945	1575
Overall Yields Without Polymerization:									
10# RVP, 400°F. EP Cat. Crkd. Gasoline, BCD	503	1510	2515	463	1390	2315	431	1291	2155
10# RVP, 400°F. EP Cat. Crkd. Gasoline, Vol. %	55.9	55.9	55.9	51.5	51.5	51.5	47.9	47.9	47.9
Cat. Crkd. Gasoline F-2 ON Clear	79.8	79.8	79.8	80.9	80.9	80.9	82.4	82.4	82.4
Cat. Crkd. Gasoline F-2 ON +3 cc. TEL	86.7	86.7	86.7	87.9	87.9	87.9	88.6	88.6	88.6
Excess Butanes, BCD	63	189	315	84	252	420	117	350	583
Cycle Oil, BCD	315	945	1575	315	945	1575	315	945	1575
Fuel Gas, MCFCD	264	790	1317	282	845	1410	300	901	1501
Fuel Gas, 10^6 Btu/CD	368	1103	1840	443	1330	2216	536	1610	2682
Overall Yields with Polymerization:									
10# RVP, 400°F. EP Cat. Crkd. Gasoline, BCD	503	1510	2515	463	1390	2315	431	1291	2155
10# RVP, 400°F. EP Cat. Crkd. Gasoline, Vol. %	55.9	55.9	55.9	51.5	51.5	51.5	47.9	47.9	47.9
10# RVP Motor Polymer, BCD	54	162	270	60	179	299	72	217	362
10# RVP Motor Polymer, Vol. %	6.0	6.0	6.0	6.6	6.6	6.6	8.0	8.0	8.0
Total 10# RVP Gasoline, BCD	557	1672	2785	523	1569	2614	503	1508	2517
Total 10# RVP Gasoline, Vol. %	61.9	61.9	61.9	58.1	58.1	58.1	55.9	55.9	55.9
Excess Butanes, BCD	19	57	95	38	113	188	66	197	329
Cycle Oil, BCD	315	945	1575	315	945	1575	315	945	1575
Fuel Gas, MCFCD	224	672	1120	247	742	1237	232	694	1158
Fuel Gas, 10^6 Btu/CD	276	828	1380	363	1089	1814	377	1130	1884
Cat. Crkd. Gasoline F-1 (Research) ON Clear	89.7	89.7	89.7	91.2	91.2	91.2	93.5	93.5	93.5
Cat. Crkd. Gasoline F-1 ON +3 cc. TEL	96.3	96.3	96.3	97.2	97.2	97.2	99.5	99.5	99.5

TABLE 3—Summary of Operating Costs for UOP MS-Type Catalytic Cracking Units

	Microspherical Silica-Magnesia			Powdered Natural			Microspherical Silica-Alumina		
Charge Throughput—BCD	900	2700	4500	900	2700	4500	900	2700	4500
Operating Costs Per Calendar Day									
1. Operating Supervision @ $350 per month	$11.70	$11.70	$11.70	$11.70	$11.70	$11.70	$11.70	$11.70	$11.70
2. Operating Labor @ $1.20 per hr. (average)	86.40	115.20	115.20	86.40	115.20	115.20	86.40	115.20	115.20
3. Maintenance Labor and Materials	66.00	132.00	182.00	73.00	146.00	269.00	66.00	132.00	182.00
4. Utilities	48.70	114.10	164.90	51.70	123.10	176.50	48.70	114.10	164.90
Net Steam @ 25c/M lbs. Circ. Water @ 2c/M gals. Fuel @ 15c/MM-Btu Electricity @ 1c/KWH									
5. Laboratory (additional) Labor and Chemicals	48.80	48.80	48.80	48.80	48.80	48.80	48.80	48.80	48.80
6. Catalyst	67.50	202.50	337.50	27.00	81.00	135.00	67.50	202.50	337.50
7. Royalty	45.00	135.00	225.00	45.00	135.00	225.00	45.00	135.00	225.00
8. Taxes and Insurance	22.00	44.00	61.00	25.00	49.00	90.00	22.00	44.00	61.00
	$396.10	$803.30	$1146.10	368.60	709.80	1071.20	396.10	803.30	1146.10
Cost Per Barrel Charge	44.0c	29.8c	25.5c	41.0c	26.3c	23.8c	44.0c	29.8c	25.5c

and air results in higher burning rates and reduced air requirements.

A simplified flow diagram of the new M-S type unit is shown in Fig 1. Briefly, the flow through the unit is as follows:

The oil feed is charged as a liquid at the base of the reactor riser; hot catalyst from the regenerator enters the riser at the point of oil injection, supplies the process heat requirements and is transported upward by the vaporized oil into the reactor.

Spent catalyst is continuously withdrawn from the upper part of the reactor dense phase to hold the level in the reactor and passes downward through the stripping section into the regenerator. Inert gas, prepared by water scrubbing a small portion of the flue gas, is used for stripping.

Catalyst passes downward through the regenerator counter-current to the air supplied at the bottom for regeneration. Additional stripping of the spent catalyst is obtained in the upper section of the regenerator where the bulk of the flue gas from the combustion of coke in the lower sections contacts the incoming catalyst.

Catalyst Flow Controls Temperature

Regenerated catalyst flows from the lower section of the regenerator into the reactor riser at a rate controlled to maintain a constant reactor temperature. The regenerator flue gas is vented to the atmosphere through an internally mounted cyclone separator which recovers entrained catalyst and returns it to the regenerator dense phase.

The reaction products pass into the fractionator vapor line through another internally mounted cyclone separator, which also recovers entrained catalyst, returning it to the reactor dense phase. The vapors enter a fractionating column where column bottoms, a side-cut stream, gasoline and gas are prepared in the customary manner.

Heat is recovered by circulating column bottoms through a steam generator and returning the oil stream to the fractionator at an intermediate point.

As already noted, a microspherical form of synthetic catalyst is employed with the new unit. A catalyst in powdered form, either synthetic or natural, can also be used with certain additions to the plant.

Two synthetic microspherical catalysts, silica-alumina and silica-magnesia, are available.

As brought out in Table 1, silica-alumina catalyst would be used if maximum octane rating is the primary consideration. The gasoline yield with silica-

magnesia catalyst is substantially higher, but the octane rating is lower.

The natural catalyst gives a gasoline yield and octane rating intermediate to the values obtained with the synthetic catalysts but with a higher coke production and greater catalyst replacement rate. It has the advantage, however, of lower cost per pound.

A production summary showing the amount and quality of yields for once-through catalytic cracking of Mid-Continent gas oil in the M-S type unit is given in Table 2. This study is based on units having charge capacities of 1000, 3000 and 5000 b/sd, with an on-stream efficiency of 90%.

Operating, maintenance and utility costs for the new type unit are said to be substantially reduced. A summary of these costs, as estimated by UOP engineers, is given in Table 3. They are based on receiving a gas oil feed, and cover the entire operation of the unit through absorption, debutanization of the catalytically cracked gasoline, and recovery of a liquid feed for polymerization.

No specifications for the feed stock used for arriving at the figure in Tables 2 and 3 were furnished by UOP.

The catalytically cracked gasoline can be finished in most cases, UOP engineers say, with no treatment other than a caustic wash and the addition of inhibitor.

Upping Octane Within Cost Limits Poses $64 Question for Refiners

By D. P. Thornton, Jr.
Assistant Editor, NPN Technical Section

Revising of Product Pipeline Specifications Emphasizes the Problem, which Small Plants Are Attacking by Catalytic Desulfurization, More Reforming, Among Other Means. Meanwhile They Watch for a "Cat Cracking" Process of Small Enough Charging Capacity to Operate with Their Thermal Equipment

THE MAJOR problem facing the small independent refiner today is the improvement of octane number of his motor fuel. Whether to install catalytic cracking to get it is his $64 question. The problem is not new but the answer must be obtained within the next 12 months, in the opinion of many independents in the Mid-Continent.

The jump to current octane levels for housebrand and premium has been expensive to at least some of the small independents. On the basis of a 5000 b/d plant equipped with thermal cracking, some reforming, and sufficient catalytic polymerization equipment to take care of the olefins produced, a reasonable gasoline recovery of 60% of crude charge may be assumed. In order to make the required volumes of 74 octane housebrand and 80 octane premium, with 3 cc. maximum tetraethyl lead, the cost is about $15,000 per month greater than it was in 1941; one plant reports around 10c a bbl.

If the small refiners in this class are forced by competition to supply a 78-80 octane housebrand gasoline and a 83-85 premium grade, as has been forecast, some sort of catalytic cracking or treating operation will be required, at a considerable increase in cost.

Some of the small independents have practically gone to the limit with present equipment in furnishing 74 octane housebrand and 80 octane premium. One said 81.5 octane with 3 cc. TEL is the maximum he can make on present equipment, and that in so doing he would seriously impoverish his supply of blending stock for housebrand.

The larger plants are not without their troubles in meeting the new conditions, if the comment of one Gulf Coast refiner is any criterion. He is running a government-owned catalytic cracker under interim lease in connection with his thermal equipment. He states that, while he has no difficulty in meeting any and all octane specifications, he is losing money making motor fuel with this equipment. His alkylation and isomerization equipment is not in operation.

The action of Great Lakes Pipeline Co. in revising motor fuel specifications effective Oct. 1 is causing concern among small independent refiners. The new specifications call for three grades of gasoline, as shown in Table 1, and two additional grades are reportedly under consideration. The old "H" grade, 73.7 min., 74.7 max. with 2 cc. TEL, has been retained, it is said, because some of the small plants cannot make base stock tenders meeting the more severe "K" grade requirements, 75.1 min., with 1.8 cc TEL. However "K" grade instead of "H" will have to be supplied generally, it is said, because refiners will be forced to meet its competition, especially if they have exchange agreements. "H" grade thus is relatively meaningless. It is stated also that this company's earlier "K" specification of 76.2 octane number with 1.8 cc. lead minimum was lowered to 75.1 as a concession to the thermal plants, and this minimum still may be revised.

The writer recently visited several typical small independents, whose plants range in size from 5000 to 10,000 b/d capacity. All have thermal cracking equipment supplemented with polymerization facilities. None could use present-day catalytic equipment of 5000 b/d charge; to most of them very considerably less catalytic charging capacity is required. They would be interested only in high-octane blending stock quantities of 1000 b/d or less because they believe it would be uneconomic to discard all or most of their thermal equipment. Generally, a maximum of 500 b/d stock having a clear 90-octane number blended with present thermal cracked naphtha would make them competitive on an octane basis for some time, they believe.

Superintendents at the plants visited say their equipment came through the war for the most part without a great deal of deferred maintenance. In two plants old heaters have been condemned and will be replaced; in both, plans are to convert the old heater for naphtha reforming and thus gain a few octane numbers in blending stock. Another plant plans to boost reforming temperatures and later to add an exchanger or two to prevent excessive processable gas loss resulting from this temperature increase in reforming.

Another plant must replace some worn out equipment. A new heater will replace the present one condemned for cracking, which will be converted to reforming, and a new desulfurizing tower will be installed ahead of the polymerizing unit.

One way of getting over the octane hump, one plant superintendent believes, is to operate a small fixed-bed cracker for

TABLE 1—Product Pipeline Gasoline Specifications

Grade	Oct. No. (minimum)	Distillation
"H" (house brand)	73.7°	10% over at 150° F.
	74.7° (max)	50% over at 250° F.
		90% over at 356° F.
		End point 410° F.
"K" (housebrand)	75.1°	10% over at 122° F.
		50% over at 220° F.
		90% over at 356° F.
		Min. total recovery 96%
"P" (premium)	79.7°	Same as for "K"

°Grade "H", 2.0 cc T.E.L. Grade "K", 1.8 cc T.E.L. Grade "P", 2.8 cc T.E.L.

high-octane blending stock in conjunction with thermal cracking and to do some reforming to provide the bulk of the naphtha for gasoline. If necessary, polymer plant capacity could be increased to take care of unsaturates. It is also planned to install bottling equipment and supply LPG for domestic use. The latter move is expected to help defray higher operating costs resulting from the other changes.

The superintendent of another plant, not now contemplating plant revamping and having no deferred maintenance on his hands, takes the position that catalytic cracking is unnecessary in his plant since it has a market for heavy residuums. This technologist is interested in catalytic retreating of straight-run into high-octane blending stock, in conjunction with thermal cracking. This will permit his plant to remain competitive for a number of years, he believes.

Still another plant manager believes that an increase in permissible leading to at least 3.5 cc. and preferably 4 cc. will bridge the octane hump until an economically feasible small thruput catalytic cracking unit is developed.

A method of securing low cost octane improvement now being installed by several Texas independent refiners involves nearly complete sulfur removal by catalytically treating the stock. In the words of a consulting engineer, "Catalytic desulfurization is proving a Godsend to many small refiners." The operation has the double-barrelled effect of boosting clear octane rating a few points and markedly improving lead response, all without reducing yields or otherwise changing characteristics of the treated vs. untreated product. Natural gasoline manufacturers handling sour gas also are using this means to help meet octane competition.

There are several patented catalytic desulfurization processes now in use which involve a clay, such as bauxite, as the catalyst in treating distillates in vapor phase. Pressure is generally less than 50 psi while temperature is around 750°F. Depending on the nature of the stock (cyclic sulfur compounds are not removed), total sulfur is reduced from 50 to 99%.

One such process and the results on a number of Southwestern crudes investigated by the Bureau of Mines recently was published.* In general an improvement of up to 3 octane numbers was reported in the clear distillate, while leaded response (with 4 cc. TEL) ranged up to 12 octane number increase over undesulfurized stock. Usually, the greatest response after catalytic desulfurization is noted with straight-run and natural gasoline, process licensors say, largely because there are apt to be more of the difficulty-removable cyclic organic sulfur compounds present in the cracked material.

* "Catalytic Desulfurization Improves Lead Susceptibility of 'Sour' Distillates", NPN Technical Section, April 4, 1945, pg. R-309.

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R-943

SILICONES AS LUBRICANTS

By T. A. Kauppi and W. W. Pederson
(Dow Corning Corp.)

Properties of Silicone Fluids for Lubrication Applications Are Compared With Petroleum Oils, and Characteristics of the Greases Discussed

Among the new chemical compounds developed for varied industrial applications are the silicone polymers, a product of Dow Corning Corp., originating from silicon and oxygen, with the addition of various organic radicals.

In lubricating applications the silicone fluids exhibit superior characteristics to petroleum oils in heat stability, oxidation resistance, non-volatility and viscosity index, it is claimed. Tests show that as a group they vary in their lubricating ability, however, particularly at high rubbing speeds or high bearing pressures. Some of the fluids approach petroleum oils in their ability to reduce wear.

The silicone greases, because of their high oxidation resistance and low volatility, are said to be finding satisfactory application in ball bearings under severe operating conditions.

SILICONE fluids possess a combination of properties which go a long way toward eliminating some of the problems encountered by the lubrication engineer. Thinning out at high temperatures and the corollary thickening at low temperatures are effects which are greatly minimized in the silicone fluids.

Fig. 1 compares the viscosity-temperature slopes of a family of silicone fluids with some typical petroleum oils. The difference is quite apparent. For instance, if a silicone fluid and a petroleum oil of high viscosity index both have a viscosity of 50 centistokes at 100° F., then at 0° F. the petroleum oil will have six times the viscosity of the silicone fluid.

Many lubrication problems involve a rather delicate balance between obtaining an oil with low enough viscosity and one with sufficiently low volatility. In other words, a kerosine with no tendency to evaporate would be very useful in some applications. Silicone fluids do not quite meet this specification but it is possible to obtain non-volatile silicone fluids in the viscosity range of 3 to 10 centistokes.

Low temperatures such as are encountered in aircraft applications often force a compromise between pour point and volatility or between pour point and viscosity. That is, a petroleum oil of low enough volatility and high enough viscosity for a given application may have much too high a pour point. Table 1 shows that the DC 200 silicone fluids, which are non-volatile and which can be obtained at viscosities of 1000 centistokes and higher, all have pour points below —50° F. Other silicone fluids, such as the DC 510, 500 centistokes, were developed for uses requiring a high viscosity fluid with an even lower pour point (—96° F.).

The utility of properties such as heat stability, non-volatility and oxidation resistance is illustrated in Figs. 2 and 3. Fig. 2 shows an apparatus designed to subject a conveyor chain to alternate high temperature (300° F.) and high humidity, with a rest period between these two extreme conditions. The purpose of this test machine was to develop lubricants which would withstand this type of operation, and Fig. 3 shows one of the test results. After six weeks of operation, the length of chain lubricated with petroleum oil had rusted so badly that the rollers would no longer turn, largely because the high temperature condition had oxidized and evaporated the petroleum oil. The chain treated with silicone fluid (DC 710) was still in excellent condition, showed almost no rusting and still had a protective film of the silicone lubricant.

Lubricity of Silicone Fluids

The properties mentioned above, low viscosity-temperature slope, non-volatility, and low freezing point, are all very desirable in a lubricant. When these properties are combined with the heat stability, oxidation resistance and general chemical inertness characteristic of silicones, the obvious conclusion seems to be that silicone fluids would make almost perfect lubricants for any sort of application. However, the one property of silicone fluids which has not yet been mentioned is that of lubrication; the above conclusion as to utility is valid only if the silicone fluid reduces friction and prevents wear between the moving surfaces involved.

One of the first experiments carried out on the lubricating properties of silicone fluids involved pumping the fluid with a small gear pump at various outlet pressures. The pump was operated at approximately normal rated speed. An initial test on an SAE 10 motor oil showed that no appreciable wear occurred during 10 days of operation at outlet pressures ranging up to 100 psi. A run made with DC 200 silicone fluid of comparable viscosity produced extreme wear, as shown by suspended particles of steel in the fluid, within one hour of operation at 25 psi outlet pressure.

When the pump was disassembled, it was found that the wear had occurred mostly in the steel bushings supporting the gears, and between the gears and the steel side-plates; apparently very little wear had occurred between the gears themselves. Several of these gear pumps, of various sizes, were being used regularly in the manufacture and processing of silicone fluids, and it was found that no trouble with wear had been encountered. However, the pumps were operated at considerably lower than normal rated speeds, and the outlet pressures rarely exceeded 100 psi.

It was apparent from the above and from similar experiences in other types of equipment that the DC 200 fluids did not have the lubricating properties of an ordinary petroleum oil. DC 200 fluids of various viscosities were being used at that time for instrument lubrication with considerable success, but whenever they were tested in applications involving high rubbing speeds or high unit bearing pressures,

The above is the principal portion of a paper under the same title presented before the Fuels and Lubricants Meeting of the Society of Automotive Engineers, Tulsa, Nov. 5, 1945.

T. A. Kauppi is Manager of Product Engineering, Dow Corning Corp. and has been instrumental in engineering for varied industrial application a wide variety of silicone products. W. W. Pederson is a product development engineer for Dow Corning Corp.

TABLE 1—Physical Properties of Dow Corning Silicone Fluids

Uses of Dow Corning Liquid Silicones	Fluid Type	Viscosity Grade Cstks. at 25° C.	Viscosity Grade SSU at 100° F.	(See †)	Freezing Point °C.	Freezing Point °F.	Boiling Point Temperature °C.	Boiling Point Pressure mm. Hg.	Flash Point Minimum °F.	Specific Gravity 25°C/25°C	Pounds Per Gallon at 25°C.	Expansion Coefficient k x 1000 per °C. 25°C to 100°C.	Refractive Index at 25°C.
Damping Fluids	DC 500	0.65	29	0.31	—68	—90	99.5	760	30	0.761	6.35	1.598	1.3748
	DC 500	1.0	30	0.37	—86	—123	152	760	100	0.818	6.84	1.451	1.3822
Hydraulic Fluids	DC 500	1.5	31	0.46	—76	—105	192	760	160	0.852	7.11	1.312	1.3872
	DC 500	2.0	32	0.48	—84	—119	230	760	195	0.871	7.27	1.247	1.3902
Instrument Liquids	DC 500	3.0	34	0.51	—70	—94	70–100	0.5	225	0.896	7.48	1.170	1.394
	DC 500	5.0	40	0.55	—70	—94	120–160	0.5	270	0.918	7.67	1.095	1.397
Liquid Dielectrics	DC 500	10	52	0.57	—67	—88	>200	0.5	350	0.940	7.85	1.035	1.399
	DC 500	20	78	0.59	—60	—76	>200	0.5	520	0.950	7.93	1.025	1.400
Foam Inhibitors	DC 500	50	198	0.59	—55	—67	>250	0.5	540	0.955	7.98	1.000	1.402
Mold Release Agents					A.S.T.M. Pour Point* °C.	A.S.T.M. Pour Point* °F.	Volatility on Heating 48 Hours at °C.	Volatility on Heating 48 Hours %					
Waterproof Treatment for Glass and Ceramic Insulators	DC 200	100	385	0.60	—55	—67	200	<2	600	0.968	8.08	0.969	1.4030
	DC 200	200	785	0.62	—53	—63	200	<2	615	0.971	8.10	0.968	1.4031
	DC 200	350	1340	0.62	—50	—58	200	<2	625	0.972	8.11	0.966	1.4032
Special Lubricants for Glass, Rubber and Plastics	DC 200	500	1850	0.62	—50	—58	200	<2	625	0.972	8.11	0.965	1.4033
	DC 200	1000	3690	0.62	—50	—58	200	<2	640	0.973	8.12	0.963	1.4035
	DC 510	50	177	0.62	<—70	<—94	250	<10	530	0.986	8.21	0.95	1.423
	DC 510	500	1710	0.66	—72	—96	250	< 5	600	1.001	8.34	0.97	1.427
High Temperature Baths	DC 550	50–75	230–346	0.77	—52	—62	250	<10	530	1.054	8.80	0.78	1.500
General Lubrication at High Temperature	DC 710	200	785	0.86	—22	—8	250	<30	480	1.095	9.14	0.73	1.530
	DC 710	350	1340	0.88	—17	+1	250	<22	500	1.103	9.20	0.72	1.535
	DC 710	500	1850	0.89	—12	10	250	<15	520	1.112	9.27	0.71	1.539

*DC 200 Fluids are not recommended for use below about —40° C., (—40° F.).
†Viscosity—Temperature Coefficient (1—V210° F./V100° F.).

the results were unfavorable. The conclusion was reached that the DC 200 type of silicone fluid has no extreme pressure lubricating properties, and actually begins to fail at unit pressures considerably lower than those normally accepted as the beginning of the extreme pressure range.

New Wear Test Devised

A few trials on the available lubricant testing machines showed they were not designed to measure lubricating properties in the pressure range in which DC 200 began to fail. Therefore, a simple device was set up to permit measurement of wear between sliding surfaces over a range of rather low pressures. As shown diagrammatically in Fig. 4, this lubrication tester merely slides a ¼ in. metal ball over a flat metal strip. The ball is held rigidly in a chuck which can be vertically loaded in the range of 500 grams to 4000 grams, and which has a horizontal reciprocating motion.

The amplitude of the oscillation is 2⅜ in. and the speed is 72 complete oscillations per minute. The flat metal strip is held stationary in a pan which contains the oil to be tested, and the usual method of evaluation is to weigh the test strip before and after a 2-hr. run. The loss in weight of the test strip, or in some cases the depth of the groove worn in the strip, is the measure of lubrication efficiency.

A few preliminary runs were made on the wear tester to determine reproducibility of results and the effect of varying loads on the amount of wear. Fig. 5 shows the results obtained when a steel ball bearing was used in the chuck and a strip of shim brass was the wearing surface. The tester was operated for two hours and the weight loss of the brass strip plotted against the load applied to the steel ball. It is apparent that the wear obtained with DC 200 silicone fluid is greater than with an SAE 10 motor oil. Similarly, Fig. 6 shows the effect of running time of the tester on weight loss of the brass strip. The wear obtained with the petroleum oil in 16 hours is about the same as that obtained with DC 200 in ¾ hour.

Since the results were reproducible and explained why difficulties had been encountered in the use of silicone fluids, the

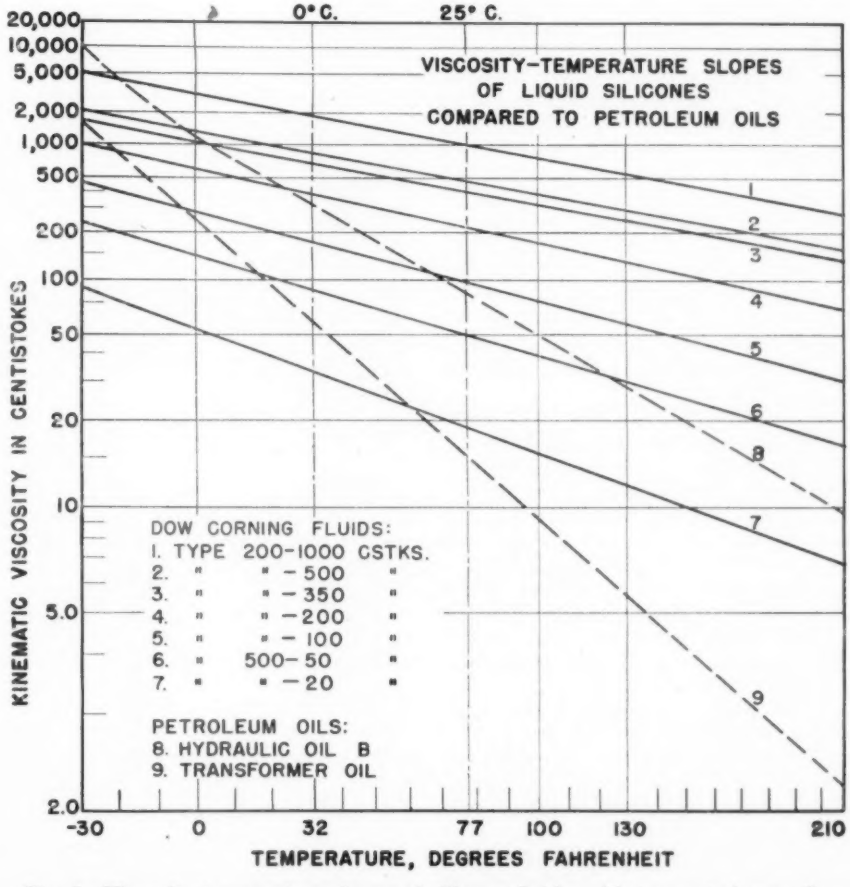


Fig. 1—Viscosity-temperature slopes of silicone fluids, with two petroleum oils.

Fig. 2—Apparatus designed to test the lubrication life of a silicone fluid (DC 710) and petroleum oils on conveyor chains cycled through a temperature chamber held at 300° F. and a humidity chamber, with rest periods at room temperatures intervening

wear tester was used to evaluate the lubricating properties of a large number of experimental silicone fluids. It was found that variations in the chemical composition of the silicone fluids had a great effect on lubricating properties, and several new types of fluids were developed.

The wear test results on one of the newer silicone fluids are also shown in Figs. 5 and 6. DC 710, in Fig. 5, shows less wear up to 2000 grams load than SAE 10 petroleum oil, but about twice as much wear at 3000 grams load. Fig. 6 shows that at 1500 grams load, DC 710 produces considerably less wear than the petroleum oil at all running times up to 16 hours. The tentative conclusion to be drawn from these results is that DC 710 is better than petroleum oil for steel-to-brass lubrication at moderate loads, but is less effective than petroleum oil at loads approaching the extreme-pressure range.

Comparative Wear Tests

The wear test results shown in Figs. 5 and 6 were obtained with a steel ball and a brass test strip. For the purpose of evaluating relative lubricating ability of various silicone fluids, however, results were obtained with a steel ball bearing and a soft steel test strip. This method of testing is much more severe, since a DC 200 silicone fluid shows five to ten times as much wear when a soft steel strip is used in place of the brass strip.

Table 2 shows wear tests results, using a hardened steel ball and a soft steel strip. The tests were run for two hours at 1500 grams load and at 4000 grams load. Distilled water, petroleum solvents and petroleum lubricating oils all show relatively little wear, and of course the petroleum motor oil is the best of the group. Among the silicone fluids, DC 200

TABLE 2—Comparative Wear Tests on Fluids

(Wear expressed in 0.0001 grams; 2-hour test)

Fluid	Load in grams 1500	4000
Distilled Water	13	10
Petroleum Naphtha	20	56
Kerosene	16	40
Hydraulic Oil	8	9
SAE 20	0	3
DC 200	740	
DC 510	700	
DC 550	330	
DC 710	0	2

and DC 510 are quite poor, DC 550 is somewhat better, and DC 710 seems to be equivalent to petroleum oil of about the same viscosity.

Wear on Various Metals

Table 3 shows the results obtained when a hardened steel ball slides on various metal surfaces. It is apparent that aluminum has the greatest tendency to wear under these conditions, and spring steel the least. DC 710 is a definite improvement over DC 200, and appears

TABLE 3—Wear Tests on Metal Combinations

(Wear expressed in 0.0001 grams; 2-hour test; 1500 grams load)

Hardened Steel Ball against	Lubricant SAE 20	DC 200	DC 550	DC 710
Brass	4	130	40	3
Aluminum	65	250	430	300
Magnesium	10	40	45	4
Soft Steel	0	750	330	0
Hardened Spring Steel	2	4	3	3

Fig. 3—After 6 weeks of testing in the apparatus shown in Fig. 2, the upper chain lubricated with a petroleum oil was badly rusted and the rollers frozen, while the lower chain lubricated with DC 710 was free of rust and operable

Meet the New Chemical Family—the Silicones

By D. P. Thornton, Jr., Assistant Editor, NPN Technical Section

SILICONE is a general term for organo-metallic polymers in which silicon, from common sand, appears in the molecule as a substitute for part of the carbon ordinarily forming the chain linkage in conventional organic compounds. Brine, sand, air and coal are the raw materials used. The resulting compound is polymerized in varying degrees to form resins and varnishes, synthetic rubbers, greases and compounds, and silicone fluids.

In the preparation, coal and sand first are heated together to form among other things silicon carbide, designated as "SiC" in the chemist's terminology. In the presence of heat, with chlorine, silicon carbide is transformed to silicon tetrachloride, $SiCl_4$, a compound chemically analogous to the familiar carbon tetrachloride used in fire extinguishers and as a solvent.

Some organic compound is selected to form the silicone, the selection being dependent on what organic group is desired in the finished product. This is reacted with chlorine to form an organic halide, designated as "RCl," the "R" standing for any organic radical. The halide then is reacted with magnesium to form an addition product frequently referred to as a Grignard reagent, commonly used in chemical synthesis.

The Grignard reagent then is reacted with silicon tetrachloride which substitutes the organic radical for one, two or three of the chloride atoms of the silicon tetrachloride, releasing magnesium and chlorine in the form of magnesium chloride. The substituted silicon halides then are separated by distillation before hydrolizing (water added). The products of hydrolysis subsequently are polymerized, whereby water is split out and the silicone formed.

In the chemist's shorthand, the procedure described looks like this:

$$\text{Coal} + \text{Sand} \rightarrow \text{SiC}$$

$$\text{SiC} + \text{SCl}_2 \rightarrow \text{SiCl}_4 + \text{C}$$

$$\text{R}' - \text{CH}_3 + \text{Cl}_2 \rightarrow \text{RCl} + \text{HCl}$$

$$\text{RCl} + \text{Mg} \rightarrow \text{RMgCl} \quad (\text{Grignard reagent})$$

$$\text{RMgCl} + \text{SiCl}_4 \rightarrow \text{RSiCl}_3 + \text{MgCl}_2$$

or

$$2\text{RMgCl} + \text{SiCl}_4 \rightarrow \text{R}_2\text{SiCl}_2 + 2\text{MgCl}_2$$

or

$$3\text{RMgCl} + \text{SiCl}_4 \rightarrow \text{R}_3\text{SiCl} + 3\text{MgCl}_2$$

$$\text{R}_2\text{SiCl}_2 + 2\text{H}_2\text{O} \rightarrow \text{R}_2\text{Si(OH)}_2 + 2\text{HCl}$$

$$\text{R}_2\text{Si(OH)}_2 \ (\text{polymerization}) \rightarrow$$

$$\left[\begin{array}{cccc} \text{R} & & \text{R} & \\ | & & | & \\ -\text{Si}-\text{O}- & & \text{Si}-\text{O}- & \\ | & & | & \\ \text{R} & & \text{R} & \end{array}\right]_x + \text{H}_2\text{O}$$

Despite their cost, at present $6.50 per pound, the silicones are being used, principally in the form of greases, in specialized lubricating applications. This is where low viscosity-temperature changes, non-volatility and low freezing point are required, as well as oxidation resistance and heat stability.

equivalent to SAE 20 except in the case of aluminum. It should be noted that test values below 5 are all equivalent, since this is the order of accuracy of the test procedure.

It is interesting to note the relative behavior of DC 200 with soft steel and spring steel and to compare this with results obtained on the pumping test. The gear pump cited previously had soft steel sleeve bearings supporting the gears, and soft steel side plates, and excessive wear occurred on these parts. Almost no wear was found on the gears themselves.

Another test, using a rotary vane-type pump, has been operating with DC 200 with excellent results. In this case, the steel parts are hardened, and the side plates are of bronze. The pump has been running for over 2000 hours at 1000 psi. pressure, and with the silicone fluid held at a temperature of 90° C. The test is being continued, and to date the wear is negligible.

The data discussed above show that considerable differences in lubricating ability exist between the various silicone fluids, and that at least some of them are suitable for a range of lubrication applications. Even the DC 710 fluid, however, is not an extreme-pressure lubricant. Since silicone fluids are totally different from petroleum oils, it is almost impossible to predict from petroleum oil experience how a particular metal combination will behave with silicones; in general a preliminary test will quickly show whether one of the silicone fluids is suitable from the standpoint of preventing wear.

Silicone Greases

Many grease problems are caused by the tendency of the oils used in greases to evaporate or oxidize, resulting in eventual hardening or caking of the grease. Since silicone fluids are definitely superior in volatility characteristics and oxidation resistance, work was started about two years ago to develop a silicone grease for ball bearings.

The first silicone bearing grease developed, DC 41, was compounded of finely divided carbon black as a thickener and a silicone fluid. Because it is an almost completely inorganic grease, DC 41 does not melt at temperatures in excess of 480° F., but more frequent lubrication is required because of increased bleeding at temperatures above 300° F. Its extreme heat resistance recommends it for special applications such as the lubrication of pumps handling molten salts and oven machinery of all kinds. DC 41 is serviceable at temperatures as low as —4° F. In the temperature range of 200 to 300° F., DC 41 has between 5 and 10 times the lubricating life of high quality petroleum greases designed for use at elevated temperatures. Tested in No. 212 bearings operating under a load of 150 lbs. at a speed of 1750 rpm, this grease was still serviceable after 2600 hours of operation at 257° F. In the same testing equipment at 347° F., DC 41 had a service life of 900 hours.

It was found that, although DC 41 performs well in ball bearings at 1750 rpm, it is not suitable for speeds in the range of 10,000 rpm. Another type of silicone grease was developed, thickened with a metallic soap, and found to give much better results at high speeds. This grease,

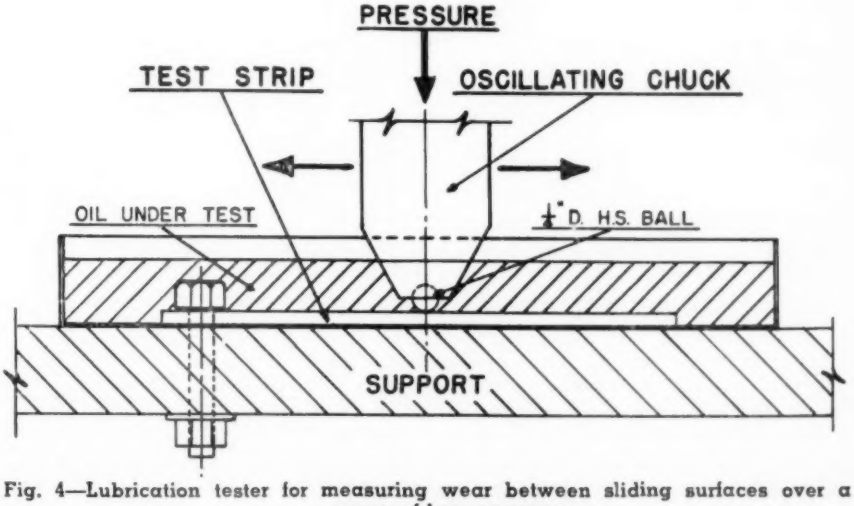
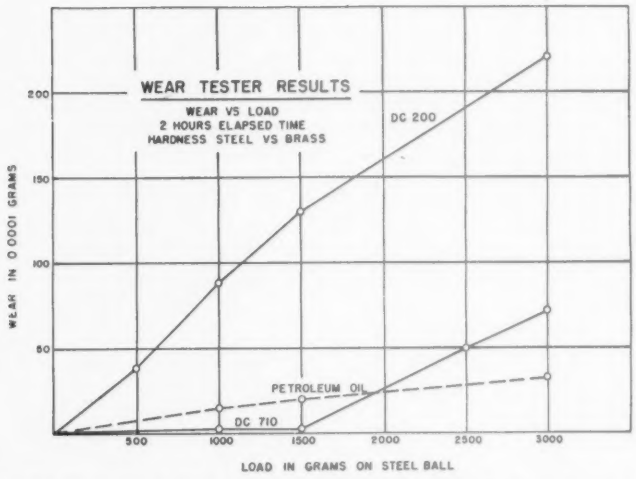
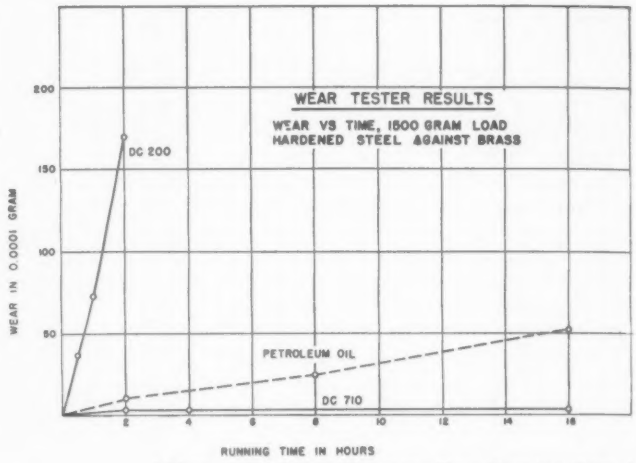


Fig. 4—Lubrication tester for measuring wear between sliding surfaces over a range of low pressures





(Photos and Charts Courtesy Dow Corning Corp.)

Data from wear test apparatus. Fig. 5 (left)—Weight loss of brass strip in lubrication tester plotted against load, with SAE 10 motor oil and two silicone fluids. Fig. 6 (right) — Weight loss of brass strip plotted against running time, with SAE 10 motor oil and two silicone fluids. (Note: In Fig. 5, the statement "Hardness Steel vs. Brass" should read "Hardened Steel vs. Brass".)

DC 44, is now under test in a No. 204 bearing operating at 10,000 rpm and 300° F. To date the bearing has operated 1500 hours and shows no signs of deterioration, as measured by temperature rise and running torque of the bearing. DC 33 is a grease similar to DC 44, but designed for low temperature use. It does not thicken at temperatures as low as —90° F. and has given good test results in bearings operating up to 300° F.

Table 4 compares the volatility of the above three silicone greases with three petroleum greases recommended for high-temperature applications. The volatility of the silicone greases at 175° C. is less than 5% in 40 hours, while the petroleum greases lost from one-third to over one-half of their original weight. After 40 hours exposure at 175° C. a crust had formed over the surface of the three petroleum greases. The silicone greases were still soft and serviceable.

Conclusions

1. Silicone fluids offer possible solutions to lubrication problems involving heat stability, oxidation resistance, non-volatility and low change of viscosity with change in temperature.

2. Different types of silicone fluids vary in their lubricating ability and in their behavior toward various rubbing metal surfaces. Some of the silicone fluids approach petroleum oils in ability to reduce wear.

3. Silicone greases, because of their oxidation resistance and low volatility, should find application in the operation of ball bearings under severe conditions and in permanently-lubricated ball bearings where long service life is essential.

TABLE 4—Percentage of Weight Lost After 40 Hours at 175° C. (347° F.)

High Temperature Petroleum Greases			Silicone Greases		
A	B	C	DC 33	DC 41	DC 44
58.3%	39.3%	34.8%	4.6%	4.2%	3.3%

Starting Next Month

Disposal of Petroleum Refinery Wastes

An Exclusive Series by W. B. Hart

STARTING with the January issue, readers of the TECHNICAL SECTION of National Petroleum News will be brought right up-to-date on the most recently developed methods and practices in disposing of refinery wastes.

The growing use of a wide variety of chemicals in processing and treating has produced solid and gaseous, as well as liquid, wastes—all requiring disposal. Also, concerted opposition by public authorities, sportsmen's associations and other agencies has developed stringent regulations covering the contamination of streams and waterways with sewage and industrial wastes.

Developments in this field have more than kept pace with the changing conditions. But the published data on these developments has been limited.

The Author

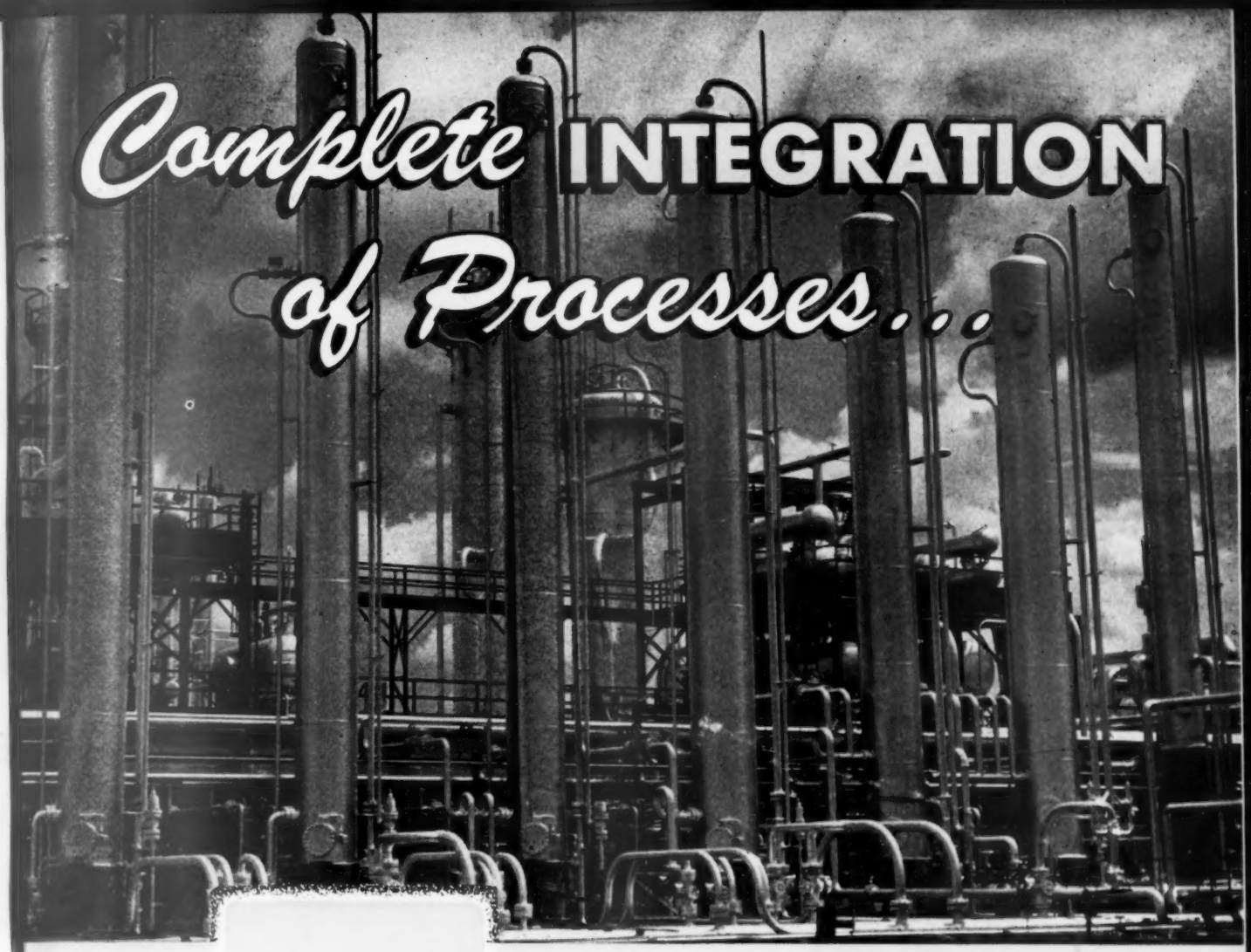
W. B. Hart, Atlantic Refining Co., Philadelphia, is an outstanding authority in the industry, especially qualified to prepare this series of articles on the important problem of disposal of refinery wastes.

Now chairman of the American Petroleum Institute's Committee on Disposal of Refinery Wastes, Mr. Hart took an important part in the preparation of early API manuals on this subject.

This series of articles, written exclusively for the TECHNICAL SECTION of National Petroleum News, meets the need felt by plant operators, large and small, for pertinent current data on this vital problem.

Mr. Hart will cover the subject thoroughly, authoritatively, and from the practical operating man's point of view.

Among other subjects, the author will discuss modern methods for disposing of catalyst wastes, dissolved solids, waste caustics and doctor solutions; the determination of the effect of refinery wastes on surface waters; the relations between petroleum companies and state and federal authorities on waste disposal; and other equally pertinent phases of the general problem.



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Inside Germany's Wartime Oil Plants

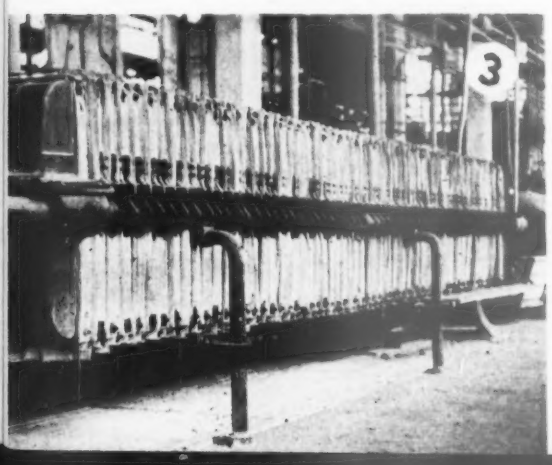
(Photos Courtesy U. S. Bureau of Mines)

1—A new type of continuous-band wax filter was found by the Technical Oil Mission in the Porta underground lubricating oil refinery. The filter elements consist of 40 rectangular pans, each 1.5 by 6 ft., arranged to form a continuous belt 6 ft. wide. The bottom of each pan is covered with filter cloth, on top of which is filter paper. As the pan moves horizontally the solvent wax slurry is poured in, the liquid filtered off under suction, and successive portions of wash liquid added and passed through the filtered cake. Pans containing the wash cake move around to an inverted position for removal of cake by blowing with air. The unit in the foreground shows the filter with the cover removed; in the background is a covered unit

Reporting Oil Mission's Trip to Germany

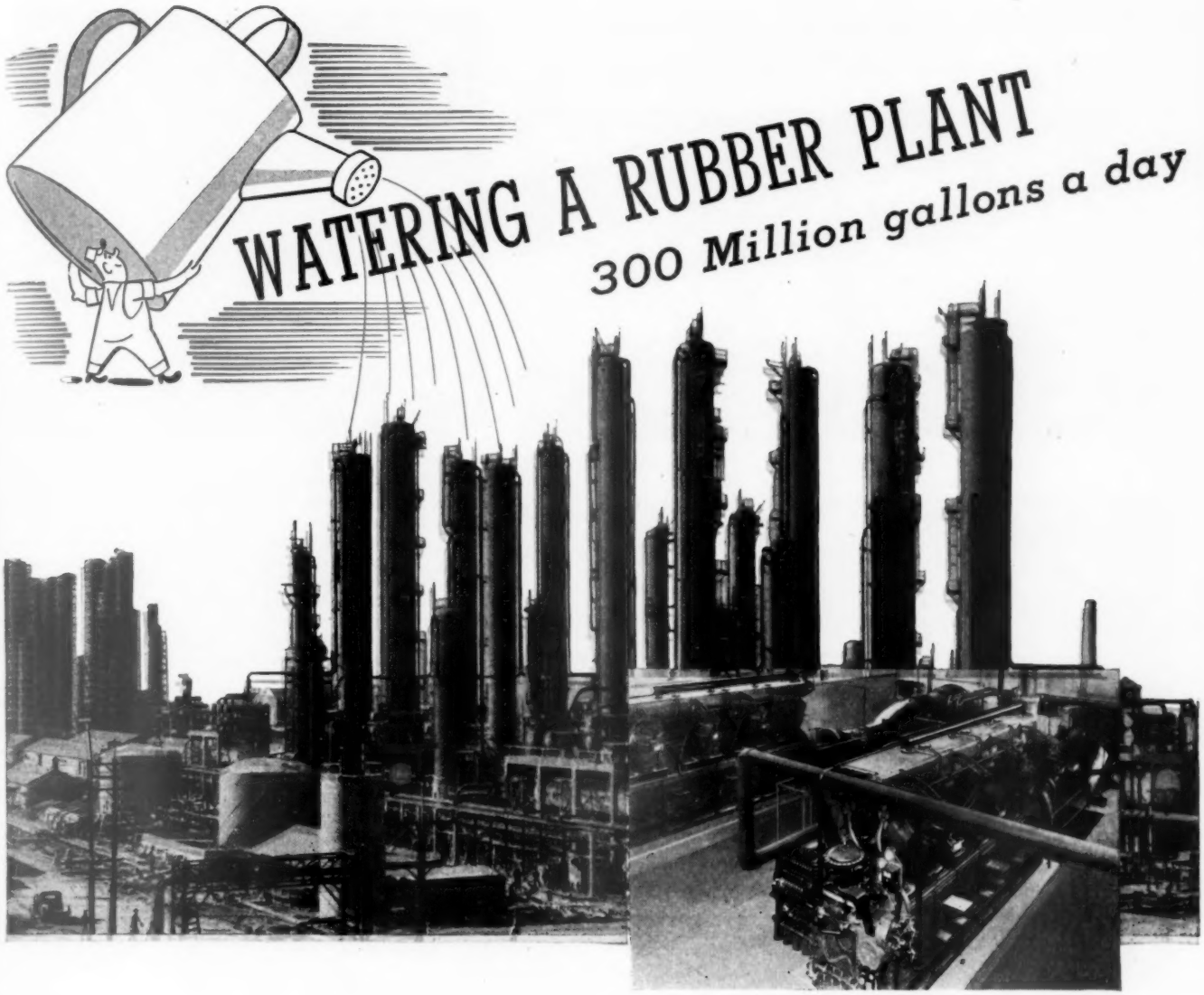
On this and the following four pages is presented the second installment of articles in the NPN Technical Section reviewing the reports of visiting technologists on the synthetic oil plants and petroleum refineries in Germany. The first of these articles appeared in the Nov. 7th NPN Technical Section. Other reports will be reviewed in this series as fast as they are "declassified" in Washington and their contents made available for inspection.

2—Hydrogenation of coal was Germany's main method of obtaining aviation gasoline, and extensive protective measures were taken to insure the continued operation of these plants. One such method was to enclose the hydrogenation vessels, which operated at pressures as high as 700 atms., in "stalls"—concrete and steel buildings designed to protect the surrounding equipment in the event one vessel exploded. This view is along the front of the stalls at the Leuna plant, one of Germany's largest installations, which had an annual capacity of 600,000 tons of finished fuel



3—Manufacture and regeneration of catalyst was an important feature of operating the coal hydrogenation and Fischer-Tropsch plants in Germany. In some instances a series of filter type presses was used in catalyst regeneration. Here the spent catalyst, after treatment, was filtered to recover valuable chemicals from the base or carrier substance. This picture shows a filter press for catalyst recovery at the Leuna plant

(Continued on page R-952)



WATERING A RUBBER PLANT

300 Million gallons a day

IT takes a lot of water to "grow" 120,000 tons of rubber. That's the annual "crop" of the world's largest butadiene rubber plant at Port Neches, Texas, where processing and cooling for capacity output require some 240,000 gallons of water every minute of every day—more than enough water for an entire city the size of Cleveland or Detroit.

Water from the Neches River a mile away is pumped to the giant synthetic rubber plant by two big automatically controlled engines driving huge centrifugal water pumps. These two engines, shown above, are alone responsible for satisfying the plant's tremendous thirst and must be operated continuously, day and night. It is said to be one of the largest water pumping installations ever made for a single manufacturing or processing plant.

Both engines are modern, V-type Cooper-Bessemers, selected for their long-range efficiency and reliability . . . and reliable they *must* be or else that rubber crop would quickly wither and die.

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R-951

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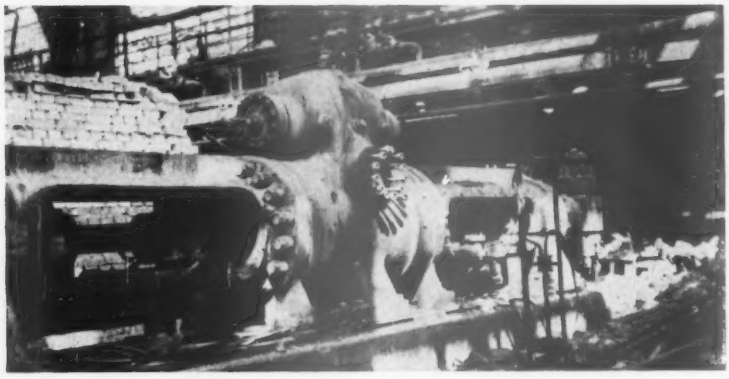

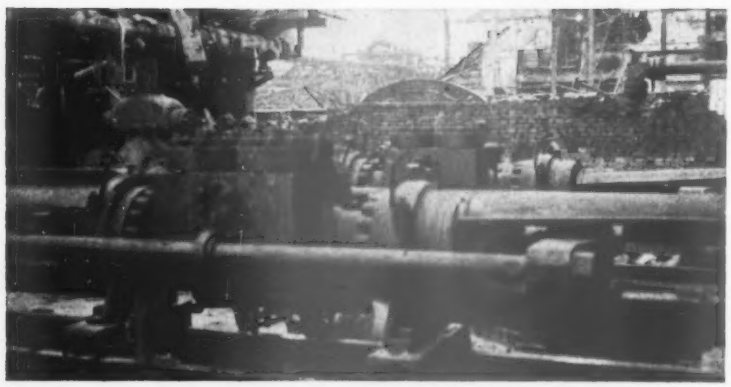

(Photos Courtesy U. S. Bureau of Mines)

ABOVE—Low-pressure Fischer-Tropsch synthesis ovens. These ovens are approximately 1.5 m. wide, 2.9 m. high and 5 m. long. Horizontal water cooling tubes extend lengthwise through the reactor, there being 29 rows of tubes, 11 tubes in each row; tubes are approximately 2.5 cm. O.D. Horizontal headers, not shown but spaced as indicated by the cut-off rows of tubes, are connected at both ends of the reactor, their ends in turn joining vertical headers at each corner of the reactor

LEFT—These two views show the type of injection pumps used in German hydrogenation plants. Top picture is of a pump at the Gelsenberg Benzine plant, one of the newer installations, which operated at over 10,000 psi (700 atms.). Lower picture shows a pump at the Scholven plant, operating at 300 atms. Note lack of walls and roof

Top of butane dehydrogenation reactors at the Leuna plant. In the foreground is a reactor partially dismantled for repairs, showing the "Y" inlet at the top for separate introduction of catalyst (side branch) and butane. In background is assembled reactor, showing insulated lines for introducing the butane feed stock

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Sharples Ethylamines are available in unlimited quantities. Specifications and use information are given below. Samples and a complete schedule of prices will be sent promptly upon request.

Specifications	Monoethylamine (70% aqueous sol'n)	Diethylamine	Triethylamine
Color	Water-white	Water-white	Water-white to light straw
Specific Gravity @ 20/20° C.	0.79 - 0.80	0.71	0.74 - 0.76
Water Insolubles	None	None	—
Minimum Amine Content	70.0% as Monoethylamine	98.0% as Diethylamine	88.0% as Triethylamine
Distillation:			
Initial boiling pt.	—	53.0° C. minimum	72.0° C. minimum
Final boiling pt.	—	59.5° C. maximum	95° C. maximum

PRESENT AND SUGGESTED USES

MONOETHYLAMINE 70% aqueous solution

PETROLEUM: Solvent extraction; preparation of amides useful in refining of lubricating oil; complex salt with CuCl useful for recovery of diolefins; intermediate for preparation of demulsifier.

SOLVENT: Selective solvent in petroleum and vegetable oil refining; solvent for wide range of organic compounds.

TEXTILE: Intermediate for synthesis of surface active agents, dyestuffs and sizing compounds.

RUBBER: Synthesis of vulcanization accelerator; stabilizer for latex.

PLASTICS: Condensing agent for urea-formaldehyde molding mixtures; preparation of various nitrogen ethylated amides which are useful as plasticizers; condensation products with other resin forming materials useful as moldings, coatings, adhesives and sizing compounds.

CERAMICS: Deflocculating agent for increasing strength of clay bodies.

PHARMACEUTICALS: Synthesis of medicinals.

PHOTOGRAPHY: Synthesis of photographic dyes.

DIETHYLAMINE

PETROLEUM: Solvent extraction; preparation of amides useful in refining of lubricating oil; complex salt with CuCl useful for recovery of diolefins; intermediate for preparation of gasoline stabilizer.

SOLVENT: Selective solvent in petroleum and vegetable oil refining; solvent for wide range of organic compounds.

TEXTILE: Intermediate for synthesis of surface active agents, dyestuffs and sizing compounds.

RUBBER: Intermediate for synthesis of a number of ultra-accelerators of vulcanization and acclerator activators for natural and synthetic rubbers.

PLASTICS: Condensation with other resin forming materials to give products useful for moldings, coatings, plasticizers and polishes.

PHARMACEUTICALS: Intermediate for synthesis of certain local anesthetics, antimalarials, antiseptics and other medicinal chemicals.

COSMETICS: Intermediate for synthesis of emulsifiers.

TRIETHYLAMINE

PETROLEUM: Agent for improving recovery of catalyst in fluid cracking operations.

SOLVENT: Catalytic solvent in chemical synthesis; solvent for many organic compounds; stabilizer for certain chlorinated hydrocarbons.

TEXTILE: Preparation of wetting, penetrating and waterproofing agents of quaternary ammonium types.

RUBBER: Preparation of accelerator activator for natural and synthetic rubbers.

COSMETICS: Preparation of emulsifying agents and germicides.

(If required for specific applications, an anhydrous grade of Triethylamine is available at increased price.)

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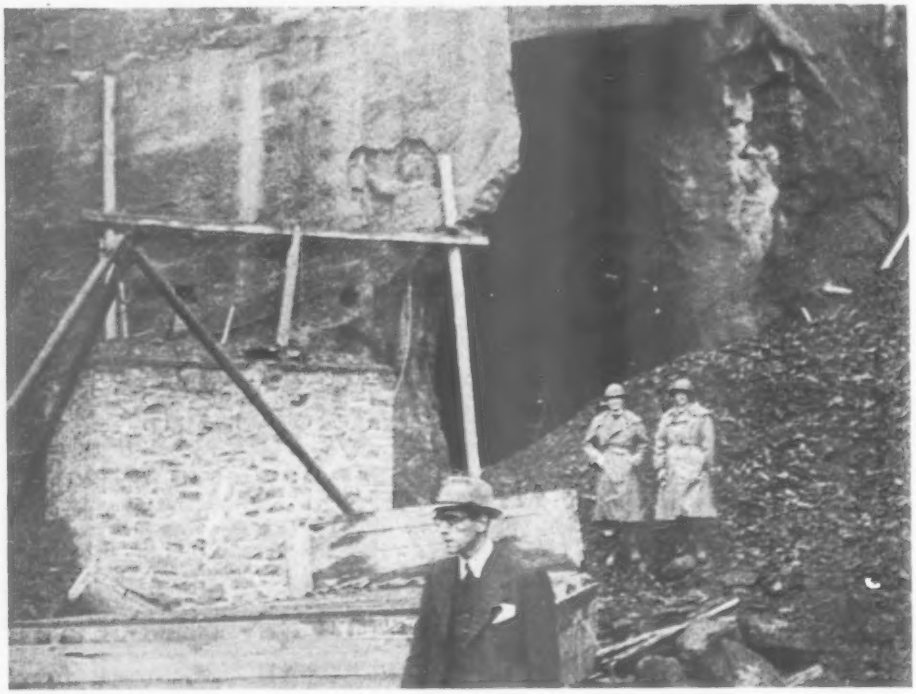
With the Technical Oil Mission in Germany

L. L. Hirst, U. S. Bureau of Mines staff, Pittsburgh, a member of the U. S. technical mission, at the Scholven coal hydrogenation plant. In the background is one of the high pressure vessels in which the hydrogenation reaction takes place at pressures up to 300 atms. The Scholven plant, built in 1936, did not have any of the newer 700 atm. units.



Entrance to the underground lubricating oil refinery (Dachs 1) at Porta, near Linden. The rubble heap and the scaffolding support show the effects of bombing. In the background are B. L. MacKusick, Pure Oil Co., and W. A. Horne, Gulf Research and Development Co., members of the U. S. Technical Oil Mission. In the foreground is H. W. A. Schroder, a Hollander, who superintended construction of the underground plant

(Photos Courtesy U. S. Bureau of Mines)

One of the few group photographs of the U. S. Technical Oil Mission to Germany. Back row, left to right: L. P. Evans, Socony-Vacuum Oil Co., Inc.; E. B. Peck, Standard Oil Development Co., who joined the Oil Mission from London, where he had been stationed several months previously; Guenther von Elbe, Bureau of Mines; W. W. Odell, Bureau of Mines; Vladimar Haensel, Universal Oil Products Co. Middle row: A. R. Powell, Koppers Co.; Ernest Cotton, Gulf Oil Corp., L. L. Hirst, Bureau of Mines; H. M. Weir, consulting engineer; H. V. Atwell, The Texas Co.; P. K. Kuhne, Gulf Oil Corp.; Bottom row: D. S. Fraser, PAW Refining Division; E. L. Baldeschwieler, Standard Oil Development Co.; W. C. Schroeder, Bureau of Mines; I. H. Jones, Koppers Co.

New Version of Fischer-Tropsch Reaction Gives 90% Yields of Iso-Paraffins

By Dr. Vladimir Haensel, Universal Oil Products Co.

Member U. S. Technical Oil Mission to Germany

Over 90% yields of iso-paraffins in the C_4 and C_5 fractions have been obtained in a modified Fischer-Tropsch process, as compared to 10 to 15% yields from the usual reaction. The new process, worked out by German technologists, combines three reactions into a single stage, first producing alcohols, which are in turn dehydrated to olefins and then hydrogenated.

Synthesis gas used is richer than usual in CO. Reaction takes place at 450° C. and 300 atms. pressure. Catalysts found suitable are predominantly oxides of zinc, aluminum and thorium, used alone or in varying combinations. Details are presented on the reaction products, as well as on the preparation of the various catalysts.

ONE-STEP synthesis of iso-paraffins from hydrogen and carbon monoxide was being achieved by German technologists working at the Kaiser Wilhelm Institut fuer Kohlenforschung, Muelheim, Ruhr, according to a Technical Oil Mission report just released.

In an attempt to increase yields of the more desirable iso-paraffins in Fischer-Tropsch synthesis reactions, the German technologists working at the Institute found it could be done by first forming higher alcohols (primarily isobutanol), then dehydrating the alcohols, and finally hydrogenating the olefins formed to the corresponding iso-paraffins. One-step synthesis was achieved by combining all three reactions into one stage.

Synthesis gas for the reaction contains about 20% more CO than hydrogen, instead of the usual two parts hydrogen and one part CO used in the conventional Fischer-Tropsch process. A variety of catalysts of varying combinations of ZnO, Al_2O_3, and ThO_2 were found suitable. The reaction is carried out at 450° C. and 300 atms.

Over 90% of the C_4 and C_5 fractions in the products produced are iso-compounds, compared to a 10 to 15% yield of iso-C_4's in the normal reaction using cobalt or iron catalyst, according to the report.

Although this synthesis work on iso-paraffins had been carried out only on a laboratory scale, it is said to be of interest to petroleum technologists in this country because of the possibility it offers of producing fuel of a good octane rating by the Fischer-Tropsch process.

Details of the work and of the catalysts used were obtained by the Oil Mission team, which included Dr. Vladimir Haensel (Universal Oil Products Co.), in questioning Dr. H. Pichler, acting director of the Institute. That portion of Dr. Haensel's report which deals with iso-synthesis investigations, which represents only a portion of the Institute's work, is presented below. The complete report is available from the Office of Publications Board, Dept. of Commerce, Washington, as their Index No. 284, under the title "Kaiser Wilhelm Institute Fuer Kohlenforschung, Muelheim, Ruhr, Germany".

Report on Iso-Synthesis

The work on iso-synthesis was started in October, 1941. As is known, the normal and middle pressure synthesis produce only small amounts of branched-chain hydrocarbons. Thus, with the cobalt catalyst about 10% of the C_4 fraction is isobutane-isobutylene, while with the iron catalyst it rises to about 15%. In the C_8 fraction, obtained with either cobalt or iron catalyst, the concentration of iso-compounds rises to 20%, while in the C_{10} fraction only branched compounds are encountered. Usually the branching does not exceed the presence of one methyl group on a long chain, and no quaternary carbon atom compounds have been found.

An examination of products from different Fischer-Tropsch plants gave similar results as far as the extent of branching is concerned, and no difference was found between normal and middle pressure products. When high temperatures and pressures were used with the iron catalyst, formation of carbon, carbonyls, and carbonyl-hydrogen compounds were encountered, but there was no increase in the concentration of iso-compounds in the liquid product.

The formation of large quantities of iso-compounds was believed to be possible, however, by first forming higher alcohols, primarily isobutanol, then dehydrating the alcohols, and then hydrogenating the olefins formed to the corresponding iso-paraffins. The combination of all three reactions in one stage makes it possible to achieve a synthesis of iso-paraffins from carbon monoxide and hydrogen in one step.

A number of catalysts have been found which are suitable for this reaction. These are:

(1) $ZnO—Al_2O_3$
(2) ThO_2
(3) $ThO_2—Al_2O_3$
(4) Al_2O_3
(5) ZnO with ThO_2, or CeO_2, or ZrO_2

The reaction is carried out at 450° C. and 300 atms. pressure. The reaction does not take place at atmospheric pressure, but as the pressure is increased the yields are improved. Above 300 atms oxygen-containing compounds begin to be formed and in increasing quantities. The throughput used in this process is 5-10 times higher than that used in the regular Fischer-Tropsch process. An example would be the processing of 20 liters of gas (NTP) over 30 gms. of ThO_2 per hour.

The preferred composition of the syn-

L. L. Newman, Bureau of Mines, member of the Technical Oil Mission, on a plant inspection trip in Germany

thesis gas used for this reaction is 1.2 CO : 1 H_2. The yield of product varies from as low as 60 gms. of C_4 and higher to 110 gms. of the same fraction; depending upon the catalyst, the yield of the C_4 and higher fraction is 80 gms. per cu. m. of gas. The yield of propane under these conditions is 10 gms. The higher compounds are produced in the following proportions:

C_4H_{10} (90% isobutane) ..... 60-70% by weight

C_5H_{12} (96-98% isopentane) ..... 20-30% by weight

C_6, C_7 and C_8 compounds ..... Small amounts

The C_6 fraction contains no neohexane, but primarily 2 and 3-methylpentanes and no normal hexane. Some naphthenes have been found in the higher boiling fraction. The yield of the C_6-C_8 fraction is higher at the lower temperature. Aside from the hydrocarbons produced, some alcohols, amounting to less than 10% of the hydrocarbon production, are also formed. This lower layer of alcohols consists of a small amount of methyl alcohol and a large amount of isobutanol. The exit gas from the iso-synthesis consists of 30% CO_2, 20% N_2, 10% CH_4 (max.), the rest being CO and H_2.

In the case of the ZnO-Al_2O_3 catalyst, an equimolar mixture of the two components is used. When more Al_2O_3 is employed, more C_3-C_4 is obtained, while when more ZnO is present, the proportion of higher compounds is increased. The catalyst is prepared from the nitrates, the dilution being such that about 2-3 liters of water are used to dissolve the required quantity of the nitrates to give 100 gms. of final catalyst.

The solution is heated to boiling and a solution of sodium carbonate is added rapidly. The precipitate is washed free of alkali, dried at 110° C. for overnight and then heated in air for 2-3 hours at 300° C. A better catalyst is prepared by individual precipitation of $ZnCO_3$ and $Al(OH)_3$ and mixing the two fresh slurries. The aluminum hydroxide is best prepared by reacting a solution of sodium aluminate with carbon dioxide or sulfuric acid.

The thoria catalyst is of interest because this catalyst is capable of performing all the functions required in the reaction. This catalyst is prepared by dissolving thorium nitrate in water (5 l. for 100 g. of ThO_2) heating to 100° C. and rapidly precipitating with sodium carbonate (no excess of sodium carbonate should be used) while stirring.

This is followed by washing until free of alkali, drying at 110° C. and further drying in air at 300° C. for 2-3 hours. The cake is broken up in 2-3 mm. granules before the final drying and used as such in the synthesis. With this catalyst, using a throughput of 20 l. of synthesis gas (NTP) per 30 g. of ThO_2, the yield of butane and higher hydrocarbons per cu. m. of synthesis gas is 60-80 g. In addition, small amounts of water and water soluble alcohols, such as methanol, is obtained.

A better catalyst than thoria alone is the thoria-alumina catalyst, used in equimolar quantities. The preparation consists in mixing fresh slurries which have been previously washed free of alkali, and then boiling off the water from the slurry mixture. Filtration apparently requires too long a time. The yield of C_4 and higher hydrocarbons using this catalyst is 100-110 gms. per cu. m. of gas.

The use of alumina alone as a catalyst is not recommended since this catalyst produces too much carbon, although the reaction does take place to give iso-compounds. The zinc oxide-aluminum oxide catalyst produces slightly more alcohols than the thoria-alumina catalyst. The carbon formation with the zinc oxide-alumina is lower than with the thoria-alumina catalyst, the former catalyst remaining white for long periods of time.

Temperature has a very profound effect upon the reaction. At 400° C., a considerable quantity of alcohols is produced, somewhat higher temperatures result in the formation of dimethyl ether, while at 450° C., isobutane is formed. At still higher temperatures, the carbon deposition becomes excessive and the catalyst has to be regenerated every few days. The size of the reaction tube is claimed to have an effect upon carbon deposition. Twelve to 15 mm. tubes can be used satisfactorily, while the use of larger diameter tubes entails the danger of excessive carbon formation.

How to Secure Official Reports of German Oil Mission

The complete reports from Germany of the U. S. Technical Oil Mission are being transferred to microfilm and will include 150 reels of approximately 1000 frames each. PAW Administrator Davies has arranged for the microfilm reels, as completed, to be available through the Library of Congress, Washington, at the usual nominal reproduction cost.

Indexes of the microfilm reels are being prepared to describe briefly the information contained in each reel. These indexes will be available for inspection in the Library of Congress and in libraries in 35 key cities, to aid in the selection of material from the reels themselves.

In addition, the most important data in the microfilm reels is being prepared in special reports, through the co-operation of the men on the oil teams and the Technical Advisory Committee of PIWC. Some of these reports have already been made and they will all be available for inspection in the Library of Congress and the 35 libraries in key cities.

The general complete publication of these special reports on the oil mission's work in Germany and of the reports of the missions from other industries will be made by the Office of Publication Board of the Department of Commerce, Washington. An index of approximately 400 of the first reports to be declassified including many of the oil mission, is now available. The index gives the number of pages in the individual report and price (nominal) at which it will sell. Oil men can secure copies of this first index, and of later indexes as issued, without cost, by writing the Office of the Publication Board, Department of Commerce, Washington 25, D. C.

Writing up reports on German oil plants in London. Left, J. Paul Jones, Phillips Petroleum Co.; right, W. A. Horne, Gulf Research and Development Co.

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API

The Coordinating Research Council

By K. G. Mackenzie

More wartime accomplishments of the petroleum and automotive industries, through the Coordinating Research Council, in simplifying the the fuels and lubricants problems of our Armed Forces are described. As reported by the chairman of the API Automotive Research Committee, these include:

Through studies in the California desert of vapor lock of tanks, mechanical changes were advised which greatly reduced fuel system and engine temperatures and thereby relieved this problem.

At the other extreme of temperatures, tests were made at Camp Shilo, in Canada, on performance of various types of fuels, lubricants and equipment, which led to great improvement in the cold weather starting and operating of automotive vehicles.

In North Africa increasing gum content in gasoline in standing storage created a serious problem. Field tests led to establishing maximum gum content for emergency conditions, and also to the selection of the most suitable gum inhibitors.

Procedure for determining the anti-knock properties of aviation fuels in actual flight was developed and the method taught to several hundred operators of laboratory engines used for anti-knock control in manufacturing aviation gasoline.

"COOPERATION in conducting elaborate and protracted tests permitted Ordnance to accomplish quickly a great amount of research and development work with an absolute minimum of military personnel, including winterization tests of equipment, fuels, and lubricants at Camp Shilo and on the Alcan Highway, and desert tests at Camp Seeley and elsewhere."

Thus did Major-General G. M. Barnes conclude his summation of the accomplishments of the Coordinating Research Council at the time of the presentation to the Council of the Ordnance Distinguished Service Award on Sept. 14 of last year. General Barnes had already stressed the following additional accomplishments which were made possible by Ordnance-CRC Cooperation.

1. Development for combat use in all land and amphibian vehicles of an all-purpose 80-octane gasoline, replacing the 7 grades formerly required to fuel vehicles from jeeps to heavy tanks, sufficiently stable for prolonged storage under severe conditions, and assuring required vehicle performance at all temperatures above 0°F.

2. Development of a heavy-duty engine oil for all military vehicles in three viscosity grades supplanting 10 and assuring maximum engine life with respect to lubrication under all military conditions.

3. Development of three gear oils to replace seven, with work now under way promising adequate supplies of the type needed for military operations.

4. Reduction of the number of greases formerly used in army ground equipment to a few specifically required for military operations and functioning so satisfactorily through broad temperature ranges as to improve the performance of many types of equipment, at the temperature extremes.

5. Contributions to solution of the problem of rust protection of material in global storage, shipment, and service, so that now it is possible to preserve material in condition for immediate use despite extended transportation and prolonged storage, and keep it in operating condition for long periods, with a minimum of attention to prevent corrosion.

The outstanding result of these accomplishments was the simplified supply system for fuels and lubricants which comprised 50% of the supplies to overseas forces.

6. Cooperation in analyzing enemy fuels and lubricants (a) to provide intelligence of the enemy's oil position, described as "a true barometer of his ability to wage war"; (b) to permit use of captured supplies during long or sustained advances; (c) to take advantages of the enemy's technical advancements.

It was, however, impossible at that time to tell the full story of the desert tests and the winterization test. To Camp Seeley in the California Desert, the Council supplied a large staff of technologists to work on the question of vapor lock. The situation is well described by Captain F. S. Peterson:*

"The tanks used by the Army when we first entered the war had evolved to their current excellence (like Topsy, they 'just growed') with changes made here and there by anyone who felt like it. The fuel system comprised a maze of pipes, valves, manifolds, filters, and other gadgets stuck here and there in the overcrowded engine compartments and the performance of these vehicles in the hot summer months of 1942 left much to be desired.

"Vapor-lock, or boiling of the gasoline in the fuel system so that the carburetor receives insufficient liquid fuel to operate the engine, occurred frequently, either while the tank was in operation, causing engine surging and loss of power, stalling, or prevented re-starting."

Ordnance and the Council jointly attacked this problem with vehemence. Changes in equipment were worked out which were approved on the ground by representatives of Ordnance and the manufacturers, and were flown to Detroit for immediate incorporation in production. Substitute equipment was actually flown to North Africa in the form of kits to be installed in tanks already there.

Changes in the cooling system were worked out on the ground, resulting in reduction in fuel system and engine temperatures. These changes were likewise immediately incorporated in the production of tanks and other ground vehicles.

High altitude tests were carried out at Yosemite, to be sure that both fuels and equipment functioned perfectly in all parts of the world.

But during this intensive activity on "India's coral sands," Greenland's icy mountains were by no means forgotten. A team composed of representatives of the War Engineering Board of the Society of Automotive Engineers, and the Council assisted in investigations conducted by the Ordnance Department at Camp Shilo, 125 miles west of Winnepeg where temperatures of —52°F. were reached.

Tests included using various types of fuels. Extent of dilution was determined and the boil-off of dilution under operating conditions, but that was not enough. Extreme sub-zero temperatures require

National Petroleum News—Vol. 37, p. 18 (Oct. 3, 1945).

Presented before the Division of Refining, American Petroleum Institute, Chicago Nov. 14, 1945.

K. G. Mackenzie, The Texas Co. New York, is chairman of the Automotive Research Committee, American Petroleum Institute.

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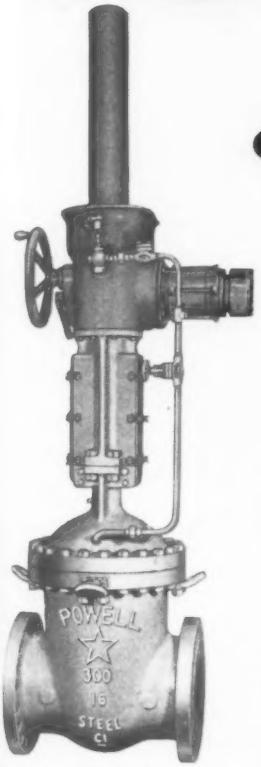
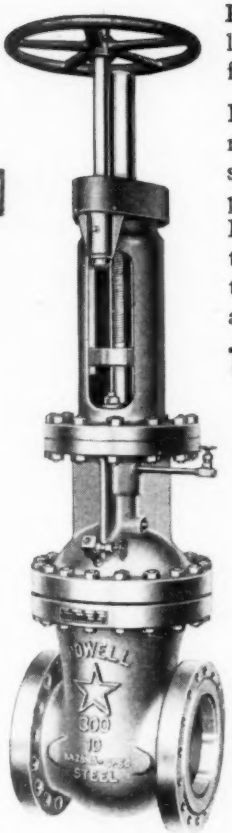


Class 300-pound, 16" Cast Steel Gate Valve designed especially for producing 100 octane aviation gasoline. Has automatic steam sealing mechanism and top mounted electric motor operator.



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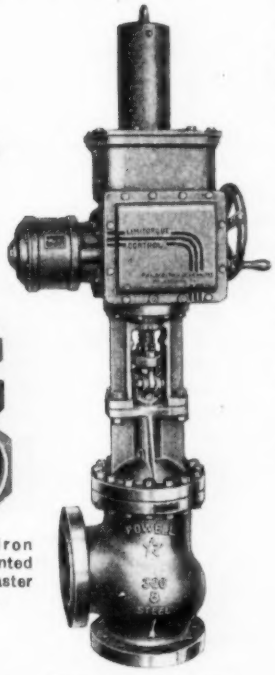
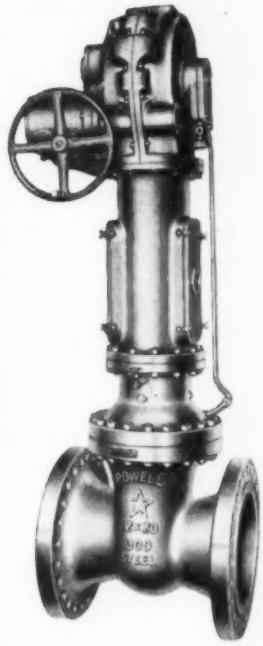


Class 300-pound Cast Steel O. S. & Y. Angle Valve. Motor operated. Adapted for high temperatures up to 1400 F.



Class 300-pound Cast Alloy Steel Gate Valve, designed to meet special requirements and to handle high temperatures. It has 12" port size venturied to 20" size end flanges to accommodate insulated pipe. Provided with top-mounted, enclosed, explosion proof, electric motor operator for quick, positive opening and closing.

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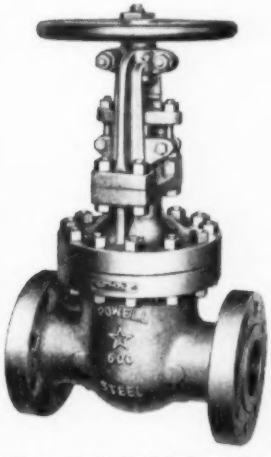

Class 600-pound Cast Steel O. S. & Y. Gate Valve. Powell Cast Steel Valves are available in all pressure classes from 150 to 2500 pounds, inclusive.

POWELL VALVES

Present Governing Board of CRC

Seven directors each from the two sustaining members, American Petroleum Institute and Society of Automotive Engineers, govern the Coordinating Research Council, Inc. The council is the group directing cooperative research in fuels and lubricants utilized in automotive and aeronautic equipment and also cooperating with the government on related matters of national interest.

Present A. P. I. representatives:

D. P. Barnard	Standard Oil Co. (Indiana)
C. E. Davis	Shell Oil Co., Inc.
G. H. B. Davis	Standard Oil Development Co.
T. G. Delbridge	Atlantic Refining Co.
R. A. Halloran	California Research Corp.
K. G. Mackenzie	The Texas Co.
G. G. Oberfell	Phillips Petroleum Co.

Present S. A. E. representatives:

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J. M. Crawford	General Motors Corp.
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W. S. James	Ford Motor Car Co.
Arthur Nutt	Packard Motor Car Co.
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J. C. Zeder	Chrysler Corp.

Headquarters of the Coordinating Research Council are at 30 Rockefeller Plaza, New York City. C. B. Veal is the permanent secretary of the Council.

not only means of heating, before starting, both the engine and fuel lines, but also keeping the battery warm since a very cold battery is a very weak battery. Many different types of heaters had been developed either by manufacturers or through cooperative endeavor and tried out, and the best types selected. The fuel was not the only important consideration under such low temperatures, since transmission oils and greases must be supplied, and extensive tests were carried out using the equipment already developed by Ordnance.

Hydraulic fluids were similarly tested, resulting in changes in the construction of the seals used in hydraulic systems.

Camp Shilo may have been considered as a field laboratory, and the next winter, an S.A.E.-C.R.C. group assisted in Ordnance tests on the Alcan Highway where the findings of Camp Shilo were proved out under extreme service conditions of long duration. A large fleet of Army ground vehicles were exhaustively tested on 1,000-mile test runs from the standpoint of fuels, lubricants and equipment. It was found necessary to modify the grease seals on the bearings.

Other equipment tested for field performance included the heaters already discussed and hydraulic systems. Another accomplishment on the highway was the development of the best operating technique under snow and icy conditions. This resulted in a very radical change in brake system design. On diesel powered equipment, a study was made on the effect of cetane number on general performance including careful observation of smoke. Tests were also made on the effect of fuel viscosity on wear of injector system parts.

The Armed Forces had been stockpiling 80 all-purpose gasoline in all parts of the world. Some stocks had been in storage for a long period of time. In certain cases, there were indications that gum content was increasing. The situation was particularly critical in North Africa. At the request of Ordnance, the Council organized and carried out elaborate and long-distance field tests under all conceivable conditions, in transport vehicles and tanks, and established maximum gum content for what might be called emergency conditions based on 5000 miles of vehicle operations or 100 hours of tank operation. At the same time, the performance of a large number of gasoline inhibitors was observed from the standpoint of deposits in fuel lines, carburetors and manifolds. This resulted in the selection of inhibitors best suited from all angles.

It should be emphasized that tests of these kinds are not limited simply to observation of conditions for continuous operation, but required complete dismantling of engines and supplemental equipment at the end of each test run.

Work which was reported two years ago has been continued on rust preventive compounds and special types of greases for both Army and Navy.

Two years ago, Secretary Veal described the work under way in determining anti-knock performance of various aircraft fuels. He pointed out the logical method of procedure would have been to start with performance in flight and carry this performance down through full scale multi-cylinder and single-cylinder engines to the laboratory test engines which must be used by the petroleum industry to control manufacture. This had been, up to that time, impossible.

In cooperation with the Armed Forces, a Working Group of the Aviation Fuels Division of the Council prepared a very complete procedure for determining the anti-knock properties of fuels in flight. This involved the development of elaborate instrumentation for properly determining these performance characteristics. This cooperative program also included determination of the effect of addition agents to Aviation Gasoline and the determination of the tendency of different fuels to pre-ignite.

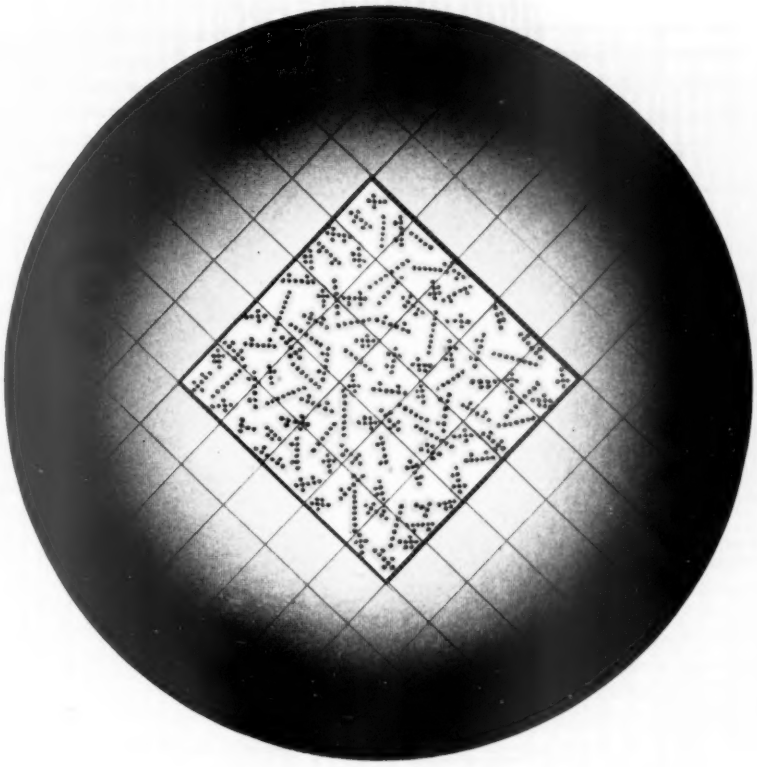
While anti-knock performance in flight was of the greatest importance, it was likewise most necessary that the 100-octane gasoline be of the uniform high quality needed. The determination of anti-knock properties of aviation gasoline is not a simple procedure. The Council, through a group of the Aviation Fuels Division not only provided complete outlines on testing procedures and techniques, but conducted forums throughout the country which were attended by the operators of the laboratory engines used for anti-knock control in manufacture. In all, almost 500 operators representing 175 individual laboratories attended what might be called instruction courses.

Extensive cooperative flight testing also was carried out on the important subject of vapor lock as affected by both front end volatility and fuel system design, and, studies were made on the relation of front end volatility to losses particularly at high altitudes.

Ninety per cent distillation point might be said at least to have been the principal controlling factor in the amount of aviation gasoline produced. Cooperative flight tests were carried out on the effect of 90% point on over-all aviation engine performance.

At the same time, cooperative work was carried out on auxiliary heating equipment, starting, and lubricant dilution. Another important development, resulting from this cooperative work was the production of greases which would permit operation under the wide extremes of temperature in the desert and at —100°F. These constitute a few of many of the accomplishments of the Council in this broad, joint, cooperative endeavor with the Armed Forces. The research of the Council resulted in proposals to the Armed Services for specifications and methods of test for a large number of lubricants.

The first step which led finally to the organization of the Coordinating Research Council was taken by the Executive Committee of the American Petroleum Institute in providing money for the employment of an outstanding automotive engineer who would serve as



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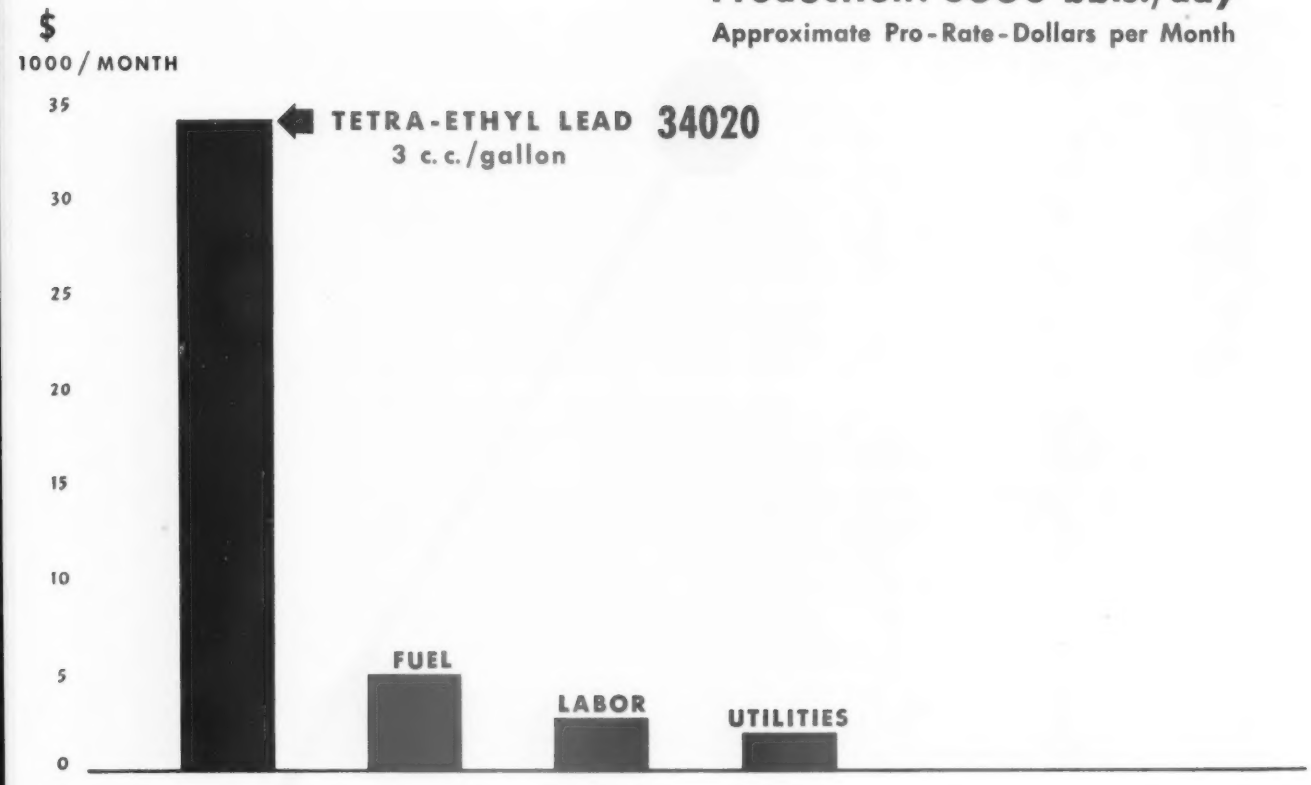

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a liaison between the Institute and the automotive and aeronautical industries. This was at the meeting of the Institute in San Francisco in November, 1941,—actually only a comparatively few days before Pearl Harbor. Thus an organization primarily designed for peacetime cooperation between the automotive, aeronautical and petroleum industries became a vital factor in the war's prosecution.

The purposes and objects of the Council, as stated in the certificate of incorporation are as follows:

"The purposes and objects of the Council are to encourage and promote the arts and sciences, in directing scientific cooperative research in developing the best combinations of fuels, lubricants and equipment powered by internal combustion engines; to promote, coordinate, and correlate cooperative research on petroleum products, and their application to and utilization in automotive and aeronautic equipment; and to afford means of cooperation with the government on related matters of national interest."

The Council is a non-profit organization, incorporated under the laws of the State of New York, and is composed of two sustaining members, the Society of Automotive Engineers, and the American Petroleum Institute. It is governed by a board of directors of 14, seven directors being selected by each of the sustaining members.

Our cooperation with the government will continue. Plans are already being formulated for this cooperation to assure to our armed services at all times the best combination of fuels, lubricants and equipment; but, beyond that, we have a duty to secure this same combination for the customers of these three industries, which are principally the consuming public.

To accomplish this most efficiently and completely, the board of the Council has taken the following steps:

(a) Since the Council is a research organization, it will not prepare and promulgate methods of test or specifications for fuels, lubricants or equipment. The results of this research work will serve as a basis for such preparation and promulgation by other organizations actively engaged in this field.

(b) Every company or person able and willing to participate in the Council's research work will be urged to do so.

(c) All of the research findings of the Council will be made available not only to the particular industries involved, but to the consuming public.

I cannot too strongly urge that all units of our industry who can participate in this work communicate with Secretary Veal and I further hope that all units of the industry will utilize to the utmost the research reports which will be issued by the Council from time to time.

The work of the Council during the war has proved conclusively not only that the aviation, automotive and petroleum industries can cooperate, but that such cooperation not only has been most fruitful of results, but is obligatory in the future. I, for one, have no question that under our peacetime economy we may look forward to even greater accomplishments for our Armed Services and the consuming public.

A P I

Peace-Time Fuel Oils From War Equipment

By Arthur E. Pew, Jr., J. Bennett Hill, and John R. Bates
(Sun Oil Co.)

If peace time motor fuel demand requires the operation of the major portion of present catalytic cracking capacity in the U.S., virgin stocks in the home heating oil boiling range can supply only a small proportion of the required charge stocks. Refiners, therefore, must turn to fractions heavier than No. 2 furnace oil boiling range and to the recycling of catalytic gas oils to find sufficient charge stocks. The effect of this, it is pointed out, will be to produce more cracked No. 2 fuel oil from heavier stocks of a lower API gravity. Recharging of once cracked No. 2 fuel also will result in a No. 2 fuel oil of lower gravity.

The economics of these operations will require the use in home heating of a No. 2 fuel oil of 28-30 API gravity, with a 10% distillation point of around 460F, is the conclusion of this study of the effect of fuel oil quality and supply on catalytic cracking. This product compares with a prewar No. 2 fuel oil of 35-38 gravity and of somewhat higher volatility. With proper design and adjustment of burners this lower gravity oil, however, will be a better fuel for the consumer, it is stated, because of its higher B.t.u. content.

THE purpose of this paper is to show the effect on fuel oil quality and supply of the operation of the catalytic cracking units built in the U. S. during the war. In particular, the resulting change in distillate fuel oil characteristics and its possible influence on domestic burner design will be discussed.

There are, at present, 96 units of 1,070,000* b/sd catalytic cracking capacity built or building in the U. S. All but 14 units, or 190,000 b/sd of capacity, represents new installations since Jan. 1, 1942. The increase of 880,000 b/sd represents new cracking capacity, since relatively minor amounts of conversion and obsolescence of thermal units have been made up by additional thermal capacity. The preferred charge for these units is obtained from the middle fraction of crude, although heavier fractions can be included if economics allow. Cracked products in the light distillate range will be about 40% for light charge but will decrease as charging stocks are made heavier.

From the middle fraction of crude and its refinery products are also derived three major finished products: (1) kerosine, (2) home heating oils, and (3) diesel fuels and other miscellaneous. These may be separated from virgin crude or from equivalent fractions of the cracked products obtained in the production of gasoline.

Kerosine and light diesel fuels consist, at the present time, almost exclusively of virgin or straight-run material. If they remain so, their quality will be little affected by changes in the extent or kind of cracking utilized in refining. However, the same fractions from which kerosine and diesel fuel are derived are also suitable charging stocks for cracking to produce gasoline. Hence, the total kerosine or diesel oil output might be reduced if the economic value of kerosine or diesel fuel as cracking stock became competitive with the existing price of these materials as such.

In the case of home heating oils, the situation is quite different. These fuels may be composed of either cracked or

Presented before the Division of Refining, American Petroleum Institute, Chicago, Nov. 15, 1945.

*Our estimate based on references 1 and 2 of bibliography and data from Houdry Process Corp.

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virgin distillates. In order to understand the effect of the new catalytic cracking equipment on these fuels, it is advisable to review the prewar types of fuel and the various types of domestic burners. This consideration will omit the uses of kerosine, wholly or partly refined, in such equipment as wick-burning incubators or sleeve type blue flame portable space heaters, kitchen water heaters, cooking ranges, etc. It will consider primarily central heating systems and the larger size space heaters.

Distillate Fuels

The present U. S. commercial standards CS-12-40 set up three classes of distillate fuels with basic specifications as shown in Table 1.

In these specifications there are no gravity limitations. Since API gravity, for any given boiling range, is a characteristic of the fuel which is roughly indicative of its chemical composition and which in turn has a bearing on the burning quality, mention of gravity will be made in this discussion.

The hydrocarbon constituents of distillate fuels which have the highest API gravity are the paraffins. Next in order are the olefins and naphthenes and the lowest in gravity are the aromatics. For this reason a straight-run product of a given boiling range from a given crude will have a high API gravity compared with a cracked product which contains less paraffins and more of the other three classes.

The carbon to hydrogen ratio of the fuel normally increases as the gravity decreases. Also, as the gravity decreases, the rate of combustion of the fuel decreases and the length of the flame consequently increases. On the other hand, the B.t.u.'s per gallon increase with decreasing gravity. Provided, therefore, that the difficulties of flame length can be overcome by burner design and adjustment, the lower gravity fuel is the better fuel for the consumer.

The No. 1 fuel has been commonly a low boiling straight-run distillate; and it has been common practice, in many sections of the country, to make this product identical, or nearly so, with kerosine. Gravity has probably averaged about 38-44 deg. for this product.

The No. 2 fuel was formerly either a straight-run gas oil cut to the proper specifications or a mixture of this with thermal cracked gas oil. While immediately pre-war, it may have averaged about 35.0 deg gravity, there was a great deal sold with gravities as high as 38.0 deg. Some burners for No. 2 fuel have been designed for this high gravity, easy-to-burn fuel, and many more have been adjusted to it. In such cases, the customer must select high gravity No. 2 fuel to get proper results.

No. 3 fuel was originally a highly cracked, low gravity fuel and had the attendant advantage of higher heat content in those burners which were specially designed to burn it.

TABLE 1—Basic Specifications of Three Classes of Distillate Fuels

Grade	No. 1	No. 2	No. 3
Distillation Temp.			
10%, deg. F. max.	410	440	...
90%, deg. F. max.	...	600	675
deg. F. min.	...	...	600
End point, deg. F. max.	560	...	...
Carbon residue, % max.	...	...	0.15
Carbon residue, on 10% residuum, % max.	0.05	0.25	...
S. U. viscosity at 100 deg., max.	...	...	45

Aside from heating, the other major use of distillate fuel is for diesel engines. While this paper is primarily concerned with the effect of war changes on household heating fuels, the conclusions will also affect diesel fuels. It must, therefore, be recognized that the cracked fuels of low gravity have lower cetane numbers than the straight-run, high gravity fuels, which have constituted very largely the fuels for the high speed diesel engines.

Domestic Burners Classifications

Domestic burners may be divided into two basic types and several sub-classifications as follows:

Type Burner	Grade Fuel Oil, No.
Vaporizing Type	
Natural Draft	1
Forced Draft	1 or 2
Pot Type	1 or 2
Vertical Rotary	1 or 2
Atomizing Type	
Vertical Rotary	1 or 2
Gun Type	
High Pressure	2 or 3
Low Pressure Atomization	3 or 2

Vaporizing Burners

Vaporizing burners rely on vaporization of fuel before combustion and are in reality, therefore, gas burners. Because of this, light fuels, such as characterized by No. 1 specifications, are most suitable and, in fact, necessary where no mechanical draft is used. Some of the latter types will operate on No. 2 grade with proper adjustments.

Atomization Burners

To satisfactorily use heavier and less volatile fuels, atomization of the oil and mixing with air before entering the combustion zone is necessary. This may be accomplished in a variety of ways, as indicated, but where the atomization and mixing is efficient, the necessity for high volatility disappears and the only volatility requirement is for sufficient front end volatility to insure proper starting of the flame.

In the five-year prewar period, the sales of oil burners were distributed, as follows, over the various types:[3]

Type	% Sales
Vaporizing	10.8
Vertical rotary	11.0
Low pressure gun	6.2
High pressure gun	71.7
Miscellaneous	0.3

In order to judge the magnitude of the effect of the new catalytic equipment, it is also necessary to discuss prewar and future demand for middle fractions.

In 1941,[7] the domestic demand for kerosine, home heating oils, diesel fuel, and miscellaneous distillate was 664,000 b/d from a crude run of 3,860,000 b/d. The breakdown into various classes was:

Distillate Demand in 1941

	B/D
Kerosine	190,000
Home Heating Oils	341,000
Diesel and Others	133,000
	664,000

This figure for home heating oil consumption corresponds to a figure of 2,268,000 burners in operation in 1941. It is estimated that in 1950, the number of operating burners will be 3,740,000 and their fuel oil consumption 473,000 b/d. (See Table 2).

If diesel oil and kerosine were and must continue to be composed of virgin stock, and the home heating oils contained about 25% of cracked material in 1941, there was then available only 75% of 341,000 or about 250,000 b/d of virgin stock in this boiling range suitable for charge to catalytic cracking. This amounts to 6.5% of the crude. It compares with a present 963,000 b/cd catalytic charge capacity, 25% of the 1941 crude run.

The refiner must turn to fractions heavier than the No. 2 furnace oil boiling range and to recycling of catalytic gas oil to find the charge for all existing catalytic units.

This will have several important effects on refinery products:

1. More cracked No. 2 fuel oil will be produced from heavier stocks than was made from charging the same stocks to thermal units and it will be of lower API gravity than that produced from charge in the No. 2 fuel boiling range.

2. The residual fuel output will be materially less because of the substitutions of catalytic for thermal cracking.

3. The recharging of once cracked No. 2 fuel will result in a No. 2 fuel of even lower gravity.

It is obvious from the above that, if the volume demand for high quality motor gasoline requires the running of all catalytic equipment or any major part of it, the gravity of No. 2 fuel oil will decrease markedly. This will come about either by the use of all available virgin No. 2 as catalytic charge or because of the low gravity No. 2 resulting from a heavier charge.

This fact may also be inferred from the excellent analysis of Moore and Elder.[4] Moore and Elder analyzed the effects of 863,000 b/cd of new catalytic capacity (as of June, 1943) and showed that when making the same quantity of

furnace oil and gasoline as in 1940, 40-50% of both catalytic and thermal equipment in the U. S. would be idle on a crude run of less than 3,555,000 b/d. Under these conditions, furnace oil would consist of more than 50% cracked products.

Such a situation is, of course, purely hypothetical, since the demand for the higher quality motor fuel and larger amounts of distillate fuel obtained by catalytic cracking will give a refiner every impetus to keep in operation his catalytic cracking units in preference to the thermal equipment. Crude runs, too, will probably not again reach as low a level as in 1940 and will remain above a 3,800,000 bbl. minimum.

It is evident from the above that furnace oil in the postwar period will be composed almost completely of catalytic distillate, except for such quantities as will bring the refiner sufficiently high price to justify its removal from catalytic cracking stocks. This catalytic distillate fuel is clean, stable, and non-corrosive to burner parts with which it is brought in contact. It has a higher heat of combustion per gallon of fuel. It is superior in these qualities to thermally cracked distillate, of which a considerable quantity was blended in No. 2 furnace oil, prior to the war.[4]

Catalytic distillate has, as pointed out above, a lower API gravity and higher carbon to hydrogen ratio than virgin stock. The lowering in gravity occurring during the cracking process depends upon factors, such as the severity of cracking and nature of charge stock. In general, however, the decrease in gravity for the same boiling range in the charge is from 4-5° API under average conditions of plant operation. This is shown in Table 3.

When catalytic charging stocks contain only fractions boiling above the No. 2 fuel range (residual fuel) the gravity of the resulting cracked No. 2 fuel can be expected to be even lower than that obtained in cracking virgin No. 2. The gravity of cracked No. 2 from residual fuel, under average conditions, is usually equal to or lower than that of the charge, as is indicated in the following example of an operation under mild conditions:

	Charge	Product
Gravity, deg API	28.8	29.3
Distillation, 10%	580	440
50%	750	510
90%	865	600

Cracking light catalytic gas oil also produces No. 2 of lower API gravity. There are meager data available, since war time operation of catalytic units required maximum production of aviation base stocks which could be obtained only from virgin fuel. It appears that the lower gasoline and gas yields and higher coke obtained from recycle gas oil results in considerably less drop in gravity when burning in the unit the same total catalyst deposit. The limited information points to about one-half the gravity drop in the production of 75% as much motor gasoline as from virgin stock, or 2 deg API.

As others[2], [4] have pointed out, the octane quality of catalytic motor gasoline is maintained throughout the heavier fractions which is not true of thermal or straight-run gasoline. A catalytic refiner will, thus, strip from the light end of No. 2 fuel fractions for inclusion in gasoline which formerly were allowed to go to No. 2 fuel.

The results of all of these factors will, in our opinion, give a No. 2 fuel oil in the future of the following properties:

API Gravity	28-30°
10% Distillation	460°F
90% Distillation	585°F

The operation of existing burners and those to be manufactured in the future on this type of fuel is being actively studied. The results of this study will be of great importance to both burner manufacturers and the refiner. Since furnace oil must compete with coal and gas on one hand and, as potential charge stock, with gasoline on the other, the ability to operate on the fuel specified above is necessary to retain its present competitive position and expand future sales of both burners and fuel.

TABLE 2—Estimates of U. S. Average Number of Central Heating Type Burners in Use and Oil Consumption Annually from 1921 to 1950

Year	Avg. No. Burners Operating	Oil Consumption—In Barrels—Barrels	Oil Consumption—In Barrels—Per Burner
1921	12,500	600,000	48.00
1922	21,500	1,040,000	48.37
1923	58,800	2,820,000	47.96
1924	101,800	5,020,000	49.31
1925	181,500	8,830,000	48.65
1926	186,275	9,715,000	52.15
1927	233,250	12,850,000	55.09
1928	310,575	17,203,000	55.39
1929	416,180	23,147,000	55.62
1930	606,300	28,769,000	47.45
1931	712,950	31,920,000	43.51
1932	799,940	36,189,000	45.24
1933	876,150	41,897,000	47.82
1934	963,670	42,575,000	44.18
1935	1,083,120	53,797,000	50.07
1936	1,246,400	69,429,000	55.70
1937	1,435,610	81,235,000	56.59
1938	1,599,150	82,388,000	51.52
1939	1,765,040	97,131,000	55.03
1940	1,998,730	115,533,000	57.80
1941	2,268,590	120,908,000	53.30
1942	2,394,180	121,506,000	50.75
1943	2,385,370	107,962,000	45.26
1944 (Est.)	2,417,185	109,406,000	45.26
1945	2,532,410	130,841,000	51.67
1946	2,739,910	137,061,000	50.02
1947	2,989,910	145,509,000	48.67
1948	3,239,910	154,050,000	47.55
1949	3,489,910	162,613,000	46.60
1950	3,739,910	172,784,000	46.20

Estimates of Sun Oil statistical research department, based upon data presented by S. B. Eckert and Arthur E. Pew, Jr. at American Petroleum Institute Houston meeting, November, 1932, and data published in "Fuel Oil and Oil Heat," and by the Oil Heat Institute.

TABLE 3—Lowering in Gravity of Catalytic Distillate By Cracking

	1	2	3	4	5	6
Charge gravity, deg. API						
Actual	32.5	32	31.2	33.8	31.4	36.2
Corrected*	33.7	36	33.6	36.8	34.7	37.2
Distillation, 10%	455	455	480	440	428	460
Distillation, 50%	530	535	549	504	592	527
Distillation, 90%	660	660	667	590	663	608
No. 2 product, deg. API	29.5	32	29.5	31.7	29.1	32.9
Distillation, 10%	460	445	475	440	492	482
Distillation, 50%	510	475	510	460	507	505
Distillation, 90%	595	535	565	490	585	550
Gravity API of No. 2 in charge, minus gravity API of cracked No. 2	4.2	4.0	4.1	5.1	5.6	4.3

*Fraction in charge of same 50% boiling point of product calculated by means of boiling point gravity constant. (E. A Jackson—Oil and Gas Journal, March 21, 1935).

$G = B + (68 - .703\ B)\ \text{Log}\ T$

Distillation data from miscellaneous sources.

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NO PEACE FOR FRACTIONATORS

By P. J. Harrington, B. L. Bragg, III, and C. O. Rhys, Jr.

Wartime demands far large volume production of hydrocarbon compounds of a high degree of purity created new operating conditions for fractionating towers. When the accepted design formulas were extrapolated to the new sizes and types demanded, operating difficulties were frequently encountered.

Examples are given of how this problem was approached in one oil company during the war. Novel methods for studying tower performance were adopted. These resulted in minor changes in the internal structure of towers of representative pre-war design in one operation, which increased atmospheric crude pipe still throughputs from less than 30,000 b/sd capacity to 40,000 to 50,000 b/sd with excellent separating efficiency. Representative light ends fractionators for separating iso- and normal butane were increased in limiting vapor loads from 20,000 b/sd to 45,000 b/sd at over 100% plate efficiency.

Through the Technical Advisory Committee of the PIWC and through PAW the findings were made available during the war to assist petroleum refineries in their war work. Extension of this type of engineering research is recommended by the authors.

AT the beginning of the war, the petroleum industry of this country had a very large investment in refinery process units. Wartime construction added another sizable increment. Of the total, it has been estimated that some 25 to 30% is in distillation-type equipment.

Fractionation continues to be the basic operation in petroleum refining, figuring prominently in a wide variety of processes from crude distillation in shell and atmospheric and vacuum pipe stills through thermal and catalytic cracking steps with associated absorption and light end recovery and separation units, to rerun stills, extractive and azeotropic distillation plants, and solvent extraction facilities.

The newer blending agent operations for aviation and motor gasoline components, such as cumene, alkylate, polymer, and isomerization products, are quite dependent on efficient fractionation. Even the growing field of chemical by-products from alcohols to additives, and from resins, plastics, and rubbers to solvents for them, involves this important process.

Long before the first world war, the theory of the separation of two-, three-, and multi-component mixtures by fractionation had been established and a rather complete literature now exists upon the subject. Design engineers in this and other industries had established a basis for producing the equipment to do the job required. This art had, however, reached the stage where only a limited amount of further investigation seemed worth while. It was common practice on multi-component mixture designs, such as those for crude stills where anything approaching superfractionation was not needed, to work from an empirical formula involving a so-called "critical" vapor velocity when sizing towers.

This formula varied somewhat from company to company, but in essence involved the fundamentally sound principles controlling the fall of liquid droplets through rising vapors with one of those constants to tie in lack of proper use of theory with experience known to the initiate as "factors of ignorance".

For number-of-plate requirements, experience was (and remains) the best guide. Where depropanizers, debutanizers, etc., were involved, plate-to-plate studies were often made assuming a 90% plate efficiency as reasonably close to the 100% which would, by definition, appear to be limiting. Even in such cases, a few extra plates were added as experience dictated. By and large, very creditable results were obtained by the design engineers.

War Accelerated Changes

The advent of the latest war accelerated a change which was already under way in tower design. At the same time that developments in aviation blending agents called for large-scale units capable of true superfractionation, the need for pure chemical compounds, such as toluene, butadiene, isoprene, and isobutane (to mention but a few), became imperative. Lack of time, materials, and manpower were coupled with a demand for increased crude runs to make well-fractionated virgin aviation base stocks and optimum quality gas oils for catalytic cracking.

The most urgent new equipment called for extrapolating design formulas for 6 to 10-ft. crude towers to 12 to 18-ft. sizes. Light ends fractionators grew to 10 to 12-ft. diameters with 50 to as many as 150 plates and reflux ratios involving Niagara-like flows across them.

The response of the industry to this demand is common knowledge and to single out the work of any one group can be justified only as a specific example on which to fasten a plea for continuing wartime engineering research, particularly in the important field of fractionation. For that reason, we have chosen two examples which point the way in the fields of crude and light-ends fractionators.

In the fall of 1941, the Standard Oil Co. of New Jersey put into operation in its Bayway refinery two single-stage atmospheric crude pipe stills, each designed to reduce 28,000 b/sd of East Texas crude to 20% bottoms, or 32,000 b/sd of West Texas crude to 30% bottoms, making a variety of well-fractionated products from a light naphtha overhead to a heavy gas oil bottom side stream. The main towers with sections of 12 ft-6 in. and 16 ft-6 in. in diameter represented considerable extrapolation from previous company (and most industry) high liquid load towers. The reflux and pump-around rates for the required fractionation called for flows as high as 115,000 gph of hot liquid across the plates of these large towers. Gaps of 5 to 25° F. were expected, based on the 95% and 5% points of adjacent cuts.

Operating Troubles Developed

In operation, difficulties were encountered with these units at less than design throughput, the fractionation being poor, while trouble was encountered in withdrawing the refined oil side stream for product and a stream for cooling to induce reflux in the tower when returned as pump-around. After some study and attempts to improve operations by changing draw-off pan arrangements, it was concluded that some kind of liquid bypassing was occurring. Plate gasket leakage as a source of trouble was eliminated and "dumping" due to plate liquid inlet side bell-cap flow reversal became suspect.

It was decided to study the hydraulics of the tower plates with air and water and half of a spare plate was set up on

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a wooden box structure where air could be passed up through the section at varied rates while water was allowed to flow across it. An extensive program was carried out by the Technical Service Division of the Standard Oil Co. of New Jersey and the Standard Oil Development Co., from which it was possible to develop quantitatively what had happened in the large tower. Valuable data for correcting the troubles encountered and for improving future design were obtained, including moving pictures of normal, abnormal, and corrected flow conditions.

The remedies for the trouble were evident once the difficulty was understood. Extremely simple changes were made to the large tower plates and it has since been possible to charge up to 45,000 b/sd of crude to these units, obtaining gaps between 95% and 5% points ranging from 20° to 35° F. on contiguous cuts. Furnace capacity is a limitation to the present feed rate. These results added in no small measure to Bayway's ability to perform outstandingly in producing war products.

In developments of this sort, it is evident that improvements are only possible as a result of the perfect cooperation of operating and technical people when studies of units pushed to their utmost are involved. In this case, great credit redounds to E. F. McTerman, Bayway atmopheric distillation department head, for just that sort of cooperation.

Reviewing the water and air studies and much work undertaken since 1941, it is possible to reconstruct the Bayway crude still tower troubles rather completely. For the sake of brevity, the fitting together of the puzzle will be passed over and the composite outlined.

Fallacy Is Exposed

A first fallacy involved that old bugaboo of dimensional similarity which has so often caught the unwary. A mouse cannot be enlarged proportionately to become an operable elephant. Designs which operate perfectly when they are used for towers of 6 ft. in diameter may run into trouble when scaled up directly to 16 ft. It has long been known and for years engineering students have been told that, if one attempts to flow liquid across a bubble cap tray, a liquid gradient is set up as is the case in a river and flow may back up and flood the tower. In practice, the student soon learns that in a few feet in a tower one can normally scarcely detect the liquid gradient even at heavy flow rates and that this gradient is negligible, compared to the usual downcomer height, so that the tower in practice does not flood from this cause.

On the other hand, novel troubles do develop in large towers at high flow rates, causing great difficulty. With vapor passing up through all of the Bayway crude tower plate bubble caps, if the liquid flow across the plate is small, uniform and satisfactory operation results. As the liquid flow increases, the resistance due to the caps, to the vapor stream, and in the original tower, to the hold-down bars on the bubble cap rows (transverse to the liquid flow) establish a gradient which may eventually amount to from one to several inches of flowing liquid. In a 16-ft. tower, even this may seem small.

The average tower, however, has in the past contained as many caps as could conveniently be fitted in to improve vapor distribution and contact and these have been designed for minimum reasonable pressure drop. The drop through such caps may be from one to several inches of flowing liquid equivalent. Now, if the head on the liquid inlet side of the plate caps, due to an "insignificant" liquid gradient, is greater than that on the liquid outlet side of the plate caps, and if this differential head is of the same order of magnitude as the small pressure drop through the caps, vapor flow will be reduced and finally stopped through the liquid inlet side caps as the liquid gradient increases.

Liquid Flow Affected

Note that overflow weir height, plate spacing, or *average* depth of liquid on the tray, do not, in themselves, affect this maldistribution of vapor flow. The important ratio is that of the plate liquid gradient to the cap pressure drop. At a given vapor loading, as more and more inlet side caps are blanked off by rising gradient as liquid flow increases, pressure drop through the fewer and fewer active vapor-loaded caps increases to tend to stabilize the tower operation. Since vapor loading normally increases with liquid loading (constant feed and product rates with increased heat input increasing vapor loading and reflux rate), a further stop to extreme blanketing usually exists.

Despite these brakes, if excessive liquid loading is built up, the head of liquid on the liquid inlet side plate caps will exceed the average plate cap pressure drop (even though this has increased as blanking takes place) and liquid will spill down through the inlet side caps to by-pass the plate and to affect adversely the fractionation. If a liquid sidestream product or pump-around draw-off is located at the outlet of a plate so bypassed, a very limited amount of draw-off is possible.

It should be pointed out that the phenomena outlined differ from "flooding" as usually defined where a tower "pukes" or will not pass the liquid charged to it. A "dumping" tower may give no external evidence of abnormal operation, especially if no large sidestream withdrawals are attempted. Many towers giving even tolerably good fractionation by the standards of experience for such towers may be "dumping" and thus losing fractionation.

As will be discussed below, gradients may become so high as to back up liquid to the top of the downcomer and so actually "flood" the tower. This is most likely where plate spacing is too close; overflow weirs too high or weir length too short; or downcomer submerged weirs are too short, too close to the plate, or partly obstructed by first-row caps. Combinations of these troubles may cause flooding or complications may be introduced by vapor cross-flow, as discussed below. The Bayway crude pipe stills did not "flood", but did "dump" badly.

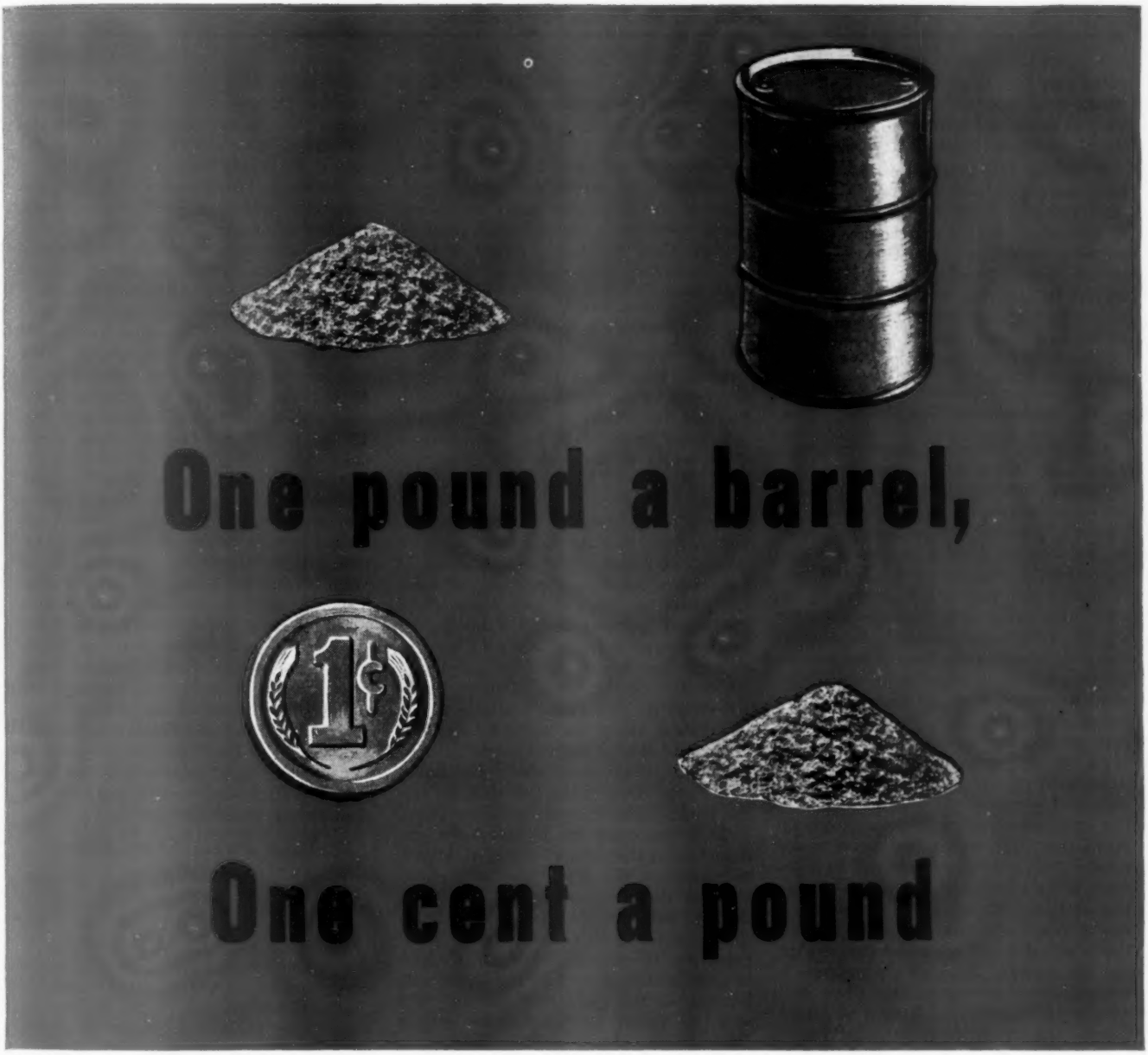
Causes of "Dumping"

To discover a cause is to make remedy less difficult. The causes of "dumping" are: (1) too long a liquid path; (2) low cap pressure drop; and (3) excessive resistance to liquid flow across the plate. Multi-pass plates reduce liquid path length but have some other disadvantages such as the possibility of maldistribution between passes. This occurred in one Jersey Company affiliate's three-pass tower. For large towers and high liquid rates, excessive gradients may be set up on each pass. Multipass replacement plates are also more expensive than other remedies for most existing towers.

Cap pressure drop may be increased where excess tower pressure is available by lowering average operating pressure or by modifying cap layout or design. The former alternative also improves the relative volatility of the lighter components compared to the heavier and this is an advantage in improving separation or reducing reflux rate up to the point where true vapor velocity limitations due to spray entrainment from properly balanced plates with uniform vapor distribution are encountered. Condenser conditions may, in other cases, be limiting.

Caps may be replaced by others designed for greater pressure drop or chokes may be installed in existing chimneys. Blanking certain caps in a properly chosen pattern will be effective as will wider cap spacing in replacement or new plate design. If the cap pattern is identical over the plate, a remedy for the troubles outlined is effected, but if caps are redesigned, blanked, choked, or more widely spaced on the liquid outlet side of the plate than on the inlet side, a better operation results, as will be discussed below. By using higher chimneys or chimney extensions on the inlet side of the plate, compensation for full rate gradient may be provided. Sloped or stopped plates have also been proposed for this purpose. Such expedients have evident disadvantages (which may not be serious) at low tower throughputs.

Considering liquid flow resistance, cap hold-down bars placed transverse to liquid flow, are the chief offenders. A few half-inch or even one-and-a-half-inch bars may seem insignificant to a scale drawing or on inspection of a 15-ft. diameter tower with 3-ft. plate spacing, but in terms of liquid flow path they can have much the same effect as the Notre Dame line would have on an aspiring high school half-back. In passing, it may be



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noted that hold-down bars paralleling the liquid flow are not favored lest they tend to cause maldistribution of liquid in the plane normal to its flow.

While the only partially explored problems associated with this type of liquid channelling will not be detailed herein, it is evident that such channeling can seriously interfere with good fractionation without tower flooding or dumping and should be avoided by careful attention to peripheral cap placement; inlet and outlet weir shape, height, location, and clearance; and by care in locating charge and product lines.

Influence of Cap Shape

Cap shape influences resistance somewhat and "streamline" caps have been proposed, but with high flow rates submergence minimizes this resistance for normally rounded caps. Cap pitch must be watched to avoid a pattern of vapor jets which tends to obstruct liquid flow at high vapor rates while promoting localized excessive spray height and poor overall liquid-vapor contact. Another of many resistance-reduction proposals involves specially designed caps with vapor slots so arranged as to blow or pump liquid across the plate, augmenting flow and minimizing gradient by a limited cross "air-lift" or vapor-jet action.

Soon after the Bayway crude pipe stills had achieved the successful operation outlined above, a large atmospheric rerun pipe still which had been under construction while the crude still troubles were being eliminated, came into operation at that refinery. In its initial run, a new phenomenon was encountered which the crude still and air-and-water studies did not explain. At high throughputs a surging action seemed to take place in a regular cyclic manner. A rush of liquid through the downcomers was clearly audible at about two-minute intervals and this period appeared to be as regular, as immutable, and at least sounded as torrential as Old Faithful itself. The sidestream draw-off from the surging plates when opened wide varied through the cycle from a full stream to a trickle.

To study this new difficulty, recourse was had to glass-paneled ports in the tower through which internal conditions could be observed. These had been discussed in connection with the crude towers, but only became necessary to study rerun tower surges. Operating management again showed commendable cooperation in permitting installation of these untried devices, which appeared less fool-proof than calculations would have them. However, in operation they were quite successful, not only on low-pressure towers, but subsequently on 100-lb. isobutane towers. Consisting of two tempered pyrex glass blanks 6 ins. in diameter with ground gasket surfaces installed in flange-type fittings on manhead covers, one was used as a spotlight port while observations were made through the other.

Excellent visibility entirely across the tower and for a considerable part of the space from downcomer to overflow weir was possible. Later scales were installed within the tower to assist in estimating liquid levels and spray heights and subsequently quite satisfactory moving pictures of the multi-pass tower mentioned above were made through such ports by the St. Clair Processing Corp. of Canada, including photographs of surges in that tower.

Observation Ports Installed

The observation ports emphasized a situation which had been hypothecated as a result of the earlier studies but which had not been fully evaluated. The air-and-water installation had one serious shortcoming in that only one plate was used. If a second had been superimposed on the first, as is the case in a tower, with liquid flowing in the opposite direction from that on the lower plate, an occurrence called vapor cross-flow would have been noted in the space between the plates at heavy liquid rates where the liquid gradient forced more than a proportionate share of vapor to rise through the lower plate on the liquid outlet side of the lower plate to below uid outlet or high vapor rate side of the top plate is above the liquid inlet or low vapor rate side of the lower plate, vapor cross-flow occurs from above the liquid outlet side. Due to the fact that the liqthe liquid outlet side of the upper plate.

That this must occur had been deduced from the air-and-water work and, in correcting the crude pipe still plates to stop dumping, an effort had been made to reduce vapor cross-flow tendency simultaneously. As noted above, if more caps are redesigned, blanked, choked, or more widely spaced on the liquid outlet side of the plate than on the inlet side, it should be possible by proper choice of cap arrangement to obtain uniform vertical vapor flow from every section of the plate for a certain liquid flow rate and total plate vapor rate. Such an arrangement will lead to vapor cross-flow concurrent to liquid flow over the plate at liquid rates below the balance rate and vapor cross-flow counter-current to liquid flow will again take place if the liquid rate is raised substantially above the balance rate of the modified plate.

Thus it is possible to fix a plate to operate completely in balance for only one liquid and vapor rate combination. This rate is usually chosen near to the anticipated maximum, assuming that some concurrent flow of liquid and vapor across the plates while coming up on the unit or during infrequent low charge rate periods will not be harmful. Perfect balance even at high rates is usually not essential to quite excellent operation.

Vapor Cross-Flow Results

To return to the rerun pipe still case an apparently reasonable balanced plate design had been incorporated in the unit. The observation ports, however, showed that at one point in the surge cycle, a small amount of overall vapor cross-flow existed. Whereas the crude still tower plates had been supported by beams paralleling the liquid flow across the plates, the heavy cast-iron rerun tray of a different manufacturer's design was supported by two deep "I" beams bisecting the two halves of the plate and running transverse to the liquid flow direction. Droplets of accumulated entrainment falling from these beams were seen to be diverted upstream relative to plate liquid flow by mild countercurrent vapor cross-flow at surging throughputs. The cross-sectional tower area was 133 sq. ft. but the clearance area between the beams and the liquid surface was only 12 sq. ft. (12 to 14-in. vertical clearance).

Across this limited area a small amount of vapor cross-flow carried considerable entrained spray upstream on the plate where it was deposited as vapor cross-flow velocity decreased. This swelled the volume of liquid trying to cross the plate This, in turn, both increased the gradient to cause more vapor cross-flow and decreased the under-beam clearance to aggravate upstream liquid pile-up. The vicious circle of events was repeated until, after a couple of minutes, pressure drop across the under-beam area became so great as to build up enough pressure beneath the liquid inlet side of the plate above to discharge over the top plate the dammed-up liquid thereon.

Vapor Purged Lower Plate

At the same time, the built-up pressure reduced the volume of incoming vapor entering the outlet liquid side of the lower plate thus forcing the vapor to purge the lower plate. With purging over, normal plate operation preceded another build-up and purge, and so on. Caps were blanked so as to eliminate countercurrent vapor cross-flow and, to some extent, those blanks were so placed as to reduce spray height in the under beam limiting area. This unit has now operated at above design load without surges or other tower limitations.

The necessarily involved description of surging may be clarified by reference to Fig. 1 which illustrates diagrammatically the state of the tower just before the plates are suddenly cleared of accumulated excess liquid. Vapors from A_1 pass through the bottom plate of those shown into space C_2, but due to liquid hold-up in space A_2, they must pass over to A_3 and thence into space C_3. Constriction at the plate support beam section (noted by items (1) and (2)) build up sufficient pressure in spaces C_2 and C_3 to cause vapors to break through from C_2 to A_4 and from C_3 to A_4, thus clearing the plates but setting the stage for another surge as vapor cross-flow reestablishes the liquid holdup in spaces A_2, A_3, A_4, etc.

The lessons learned from the Bayway crude and rerun stills and the air-and-water studies were put to use in the design of new pipe stills for Baltimore and Baton Rouge. Improved plates were de-

signed for these units which were otherwise duplicates of the Bayway units and intended to reduce 30,000 b/sd of Southwest Louisiana or equivalent crude to 16% bottoms. It was anticipated that the plate changes incorporated in these units would permit over-design throughputs but since the war program would permit no hold-up in the construction work already under way to reduce the size of the tower and since the refineries could increase their war contribution with excess crude distillation capacity or efficiency, larger charge pumps, more furnace surface, and other limited changes were made to the units while under construction to permit taking advantage of some of the expected excess tower capacity.

Both these units have come up to expectations as may be evidenced by a few figures on the Baton Rouge unit. Within four days of first firing, the charge rate was 30,000 b/sd, and the unit has taken 50,000 b/sd of Southwest Louisiana crude to 18% bottoms with adjacent cut gaps of from 10° to 15° F. better than design. The furnace limits capacity. Vapor velocities are over 200% of the "critical" velocity mentioned previously.

In the course of studies involving greatly increasing alkylate producing capacity in the Jersey Company refineries early in the war, a 10-ft. diameter, 50 single-pass-plate isobutane tower was tested. This tower charged some 7500 b/sd of alkylate and butanes, producing 5000 b/sd of 80% isobutane content overhead product, about 1% of the butanes left in the bottoms being isobutane. Reflux meters indicated 25,000 to 30,000 b/sd but careful heat and material balances proved that much of the pumpback was being carried over from the tower top as liquid. Despite this upset condition, the tower operated smoothly and had an overall plate efficiency as usually defined of about 80%.

Isobutane Tower Studied

With the crude and rerun still findings in mind, differential pressure drop manometers were installed on each set of five adjacent plates of the tower, gauge glasses were used near the tower top and bottom to indicate liquid levels in the downcomers, and, subsequently, observation ports were placed on the tower at several points. An extended study revealed the following information:

Whereas the crude stills had dumped but had not flooded, the isobutane tower was found to be badly flooded. High liquid flow rates had caused gradients across the plates which upset vapor flow and resulted in countercurrent vapor cross-flow as outlined above. In this case, however, due partly to a considerable number of transverse plate support beams, vapor cross-flow velocity was so high over much of the plate as to entrain liquid spray upstream. Unlike the rerun still, however, surging did not occur and the build-up of liquid was only limited by filled downcomers.

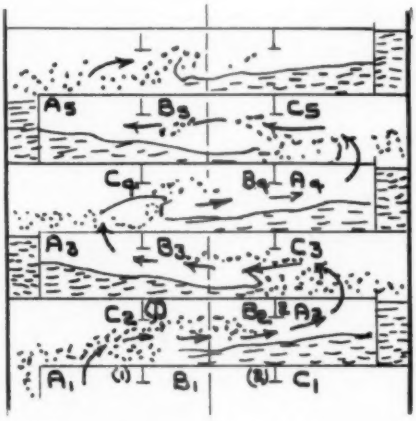
With 27 in. of plate spacing, there was good evidence that the outlet weirs were submerged about 12 in. while the plate submergence on the liquid inlet side in the tower proper was as great as 25 in. It is remarkable that smooth operation and fair fractionation resulted under these conditions. When the tower load was reduced to eliminate flooding, a total overhead vapor load (product plus reflux) of only 20,000 b/sd was possible.

The remedies outlined above were applied to the tower plates and, in addition, downcomer to plate clearances were increased, and some caps located too close to overflow weirs removed. It was necessary to make two successive plate modifications but well before the close of the war this tower was able to handle 45,000 b/sd of vapor and liquid load with a plate efficiency of at least 106% using the most conservative of careful special duplicate sample analyses. There was good reason to believe the true efficiency was more nearly 145%.

Tower Plates Modified

In all, six Jersey Company affiliate alkylation unit isobutane towers were modified with a most gratifying effect on alkylate and aviation gasoline output. It should, of course, be noted that seasonal condenser water temperature conditions and other considerations limited application of the findings and in no case has a tower limitation as such been reached. Reboiler capacity was provided by using 100 lb. steam on units designed for either high-pressure or exhaust steam, vapor and liquid lines from the reboiler to the tower being increased in size. Preheat was also increased by using live steam, supplemented by improved techniques to minimize pre-heater fouling.

It may be well at this point to mention the need for consideration of tower charge hydraulics. Just as an obstruction in any single-plate downcomer must result in flooding the entire tower, so upset hydraulics where charge enters a tower may lead to flooding. Cold feed, or oven hot or slightly vaporized feed, particularly in a tower producing a high bottoms-to-charge ratio, may impose an excessive liquid load on the feed and lower plates and flash disturbances where such feed meets hot reflux in the tower may further upset hydraulic balances easily offected by small absolute forces. In some cases, a plate with vapor by-passes to permit introducing feed, mixing it with reflux, and allowing vapor separation may be desirable. Often over-flashing feed by preheat in excess of the theoretical optimum for fractionation may be desirable when liquid load at and below the tower feed is limiting capacity. The small loss in fractionation efficiency due to over-flashing may be more than made up by the increases in reflux possible when minimizing below-the-feed flooding tendency.



Notes:
1. Conditions shown are for countercurrent vapor cross-flow typical of plate action on the Bayway rerun pipe still prior to plate revisions.
2. Arrows show direction of vapor cross-flow.

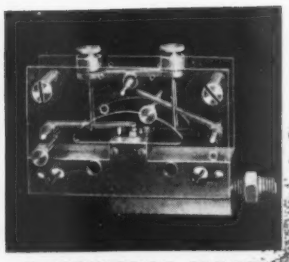
Fig. 1—Typical Counter-current Vapor Cross-Flow

Reference has been made to isobutane tower plate efficiencies. It is, perhaps, unfortunate that the generally used criterion for fractionating efficiency is the approach to point equilibrium. When the work done by a commercial plate equals that which would result from establishing equilibrium between the liquid and vapor entering that plate, it is said to be 100% efficient. This expression discourages attempts to exceed a 100% figure. Where liquid enters a commercial plate, however, it *successively* contacts a series of vapors of constant or varying composition, depending on the degree of vapor mixing between plates. Lewis° has shown that a plate efficiency, expressed in the usual terminology, of as much as 300% may be possible on a commercial plate under certain conditions. Probable overall average plate efficiencies in the isobutane towers discussed have reached 145% and higher levels may be possible with improved tower designs.

The Standard Oil Development Co. plans to continue its fractionating tower studies, using the most up-to-the-minute results of its work to improve the efficiency and capacity of other existing equipment as has been done in the examples cited. Where bottlenecks other than towers limit units, those may be removed as such, or equipment may be doubled up so as to release towers here and there for new units or duties. Worthwhile economies will be possible in new unit designs when advantage is taken of the lessons learned from such studies as are outlined above.

It is hoped that extension of these studies by other companies will increase the ability of the petroleum industry to offer to the nation in peace, as in war, better products at lower costs. Unequivocally, although the war is over, there is "no peace for fractionators". Indeed, the whole wide field of process equipment unit design demands engineering research and more engineering research.

° W. K. Lewis, Jr., "Rectification of Binary Mixtures", *Jour. Ind. and Eng. Chemistry*, 28, 399 (1936).



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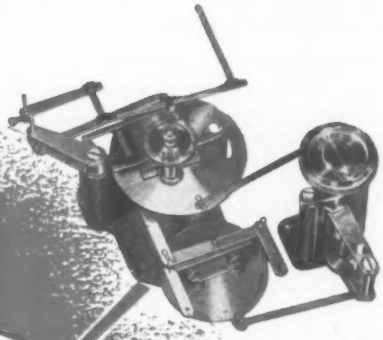

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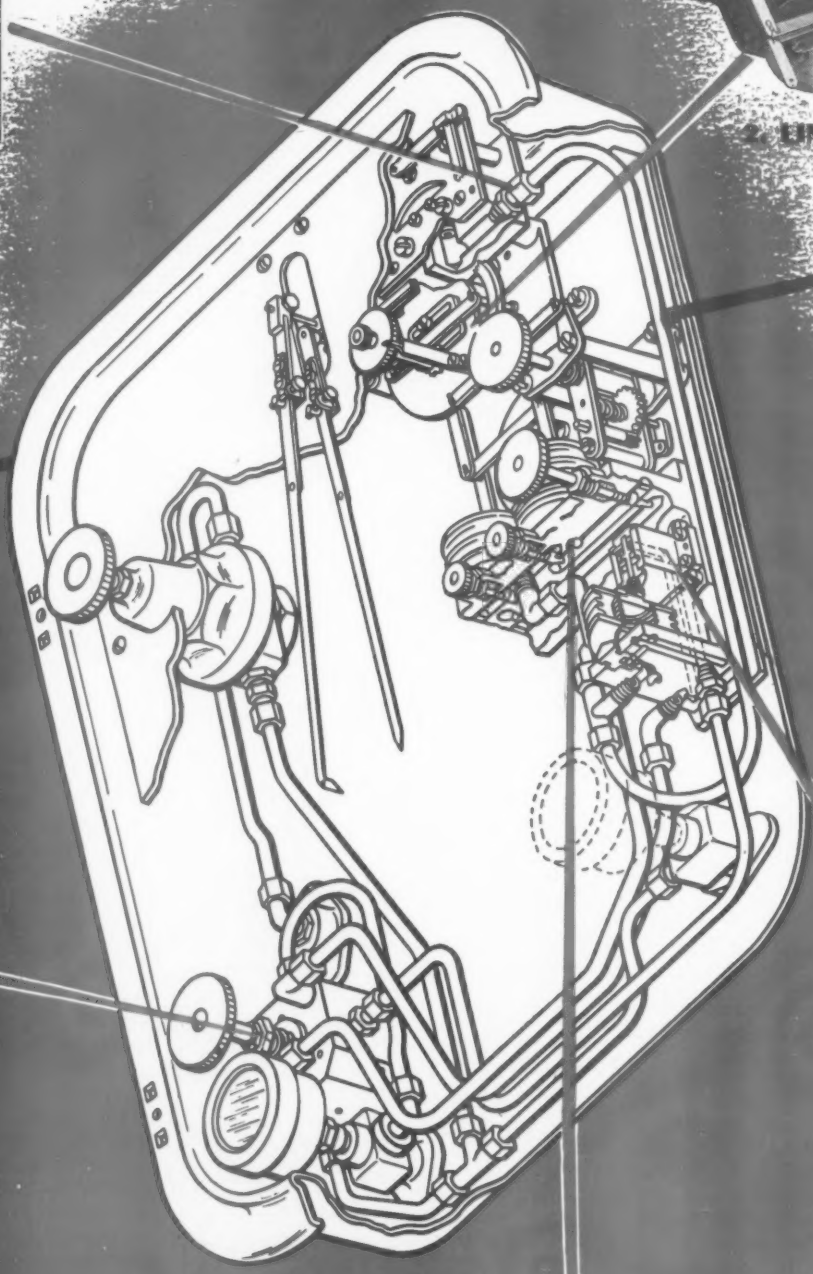

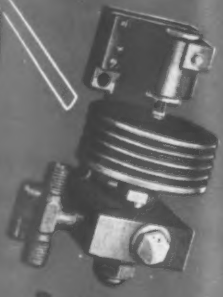

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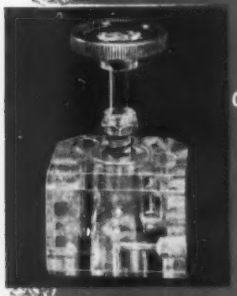

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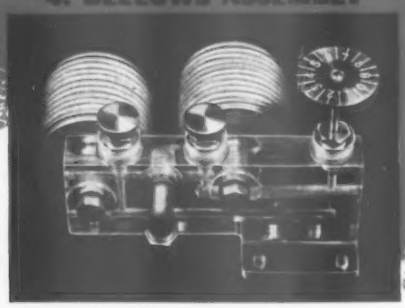

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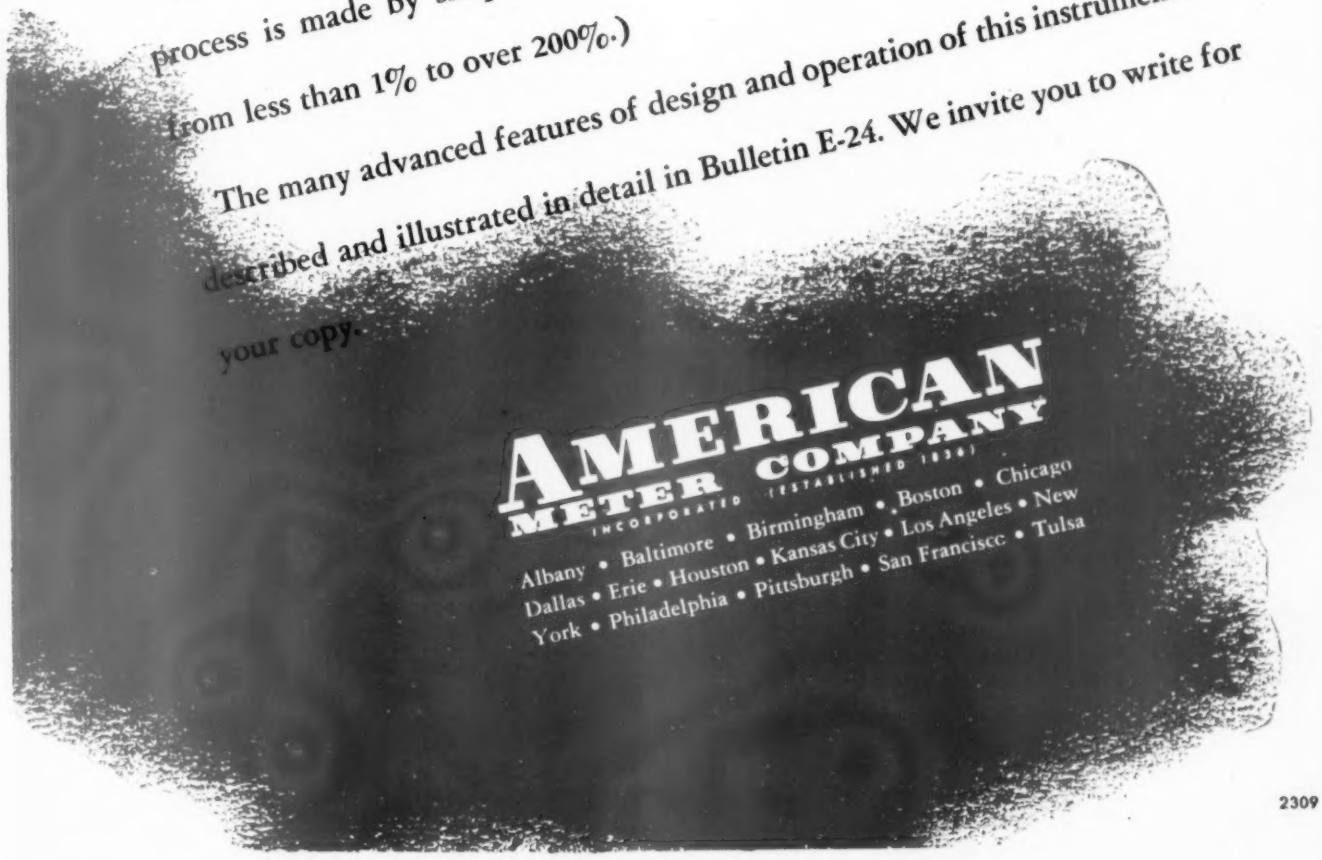

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High-Capacity Operations On Fluid Cracking Units

By E. V. Murphree, E. J. Gohr, H. Z. Martin, H. J. Ogorzaly, and C. W. Tyson

Methods were developed during wartime operations, within the limitations of carbon burning capacity, to improve feed rates and production capacities of Fluid catalytic cracking plants. It is stated that an "ultimate" feed capacity greater than the wartime maximum can be attained in motor gasoline operations.

One such means was the improving of the carbon-conversion relationship. This was accomplished (1) by mechanical improvements in the stripper which provided for more efficient removal of entrained hydrocarbon vapors and greatly reduced the laydown of carbon there; (2) by reducing the catalyst-to-oil ratio by raising the regenerator temperature. Fresh feed charge capacity was increased 15-20% by reason of the reduction in carbon yield at the lower catalyst-to-oil ratio. Also, a larger proportion of oxygen is utilized in regeneration, resulting in a higher carbon burning capacity. Representative plant data is presented to show the results obtained by the above methods.

THE basic factors which affect capacity of a Fluid catalyst cracking plant may be summarized as follows:

1. Cracking capacity
2. Feed preheat capacity.
3. Carbon-feed stock conversion relationship.
4. Regenerator carbon burning capacity.

Due to a flexible design and adequate catalyst activity maintenance, the cracking capacity does not normally limit the performance of the plants of the affiliates of the Standard Oil Co. (N. J.). The reactor size and allowable pressure are great enough so that it is possible to maintain reasonable catalyst quantity and gas velocity in that vessel.

Also, there is sufficient spare heat in the fractionator bottoms to provide the increase in feed temperature required to maintain reactor temperature as the feed rate is increased. During the wartime these plants have been operated to catalytically crack the amount of oil consistent with the maximum amount of carbon which can be burned in the regenerator.

Two Basic Methods

With carbon burning capacity limiting there are two basic means by which the capacity of a Fluid catalyst plant can be increased:

(a) Improving the carbon-conversion relationship; that is, the relationship between the yield of carbon based on feed and the extent to which the feed is catalytically cracked.

(b) By alteration of the conditions which limit regeneration capacity, so that a greater carbon burning rate is possible. Both methods have utilized in the plants of the Jersey affiliates and will be discussed more fully below.

Improving Carbon-Conversion Relationship

Two methods for improving carbon-conversion* relationship have been applied. One of these involves the efficiency of removal of the entrained hydrocarbon vapors which are carried down from the reactor into the stripper in the interstitial space between the catalyst particles. If allowed to remain long in contact with the catalyst in the stripper this material can become severely cracked and lay down much unstrippable carbon. Therefore, it is advantageous to remove these vapors as quickly and completely as possible.

Improvement of stripper efficiency has been successful in reducing the hydrocarbon carryover to the regenerator by an amount equivalent to approximately 0.5-0.7% carbon by weight based on feed. This improvement has been attained by the installation of long thin box-like cells in the annular stripping section as shown in Fig. 1.

Because stripping of the catalyst is not entirely complete, even in the improved stripper, further improvement in carbon-conversion relationship is obtained by reduction of the ratio of catalyst to oil feed. It is obvious that the same amount of heat can be transferred from the regenerator to the reactor either by a high catalyst rate with a low difference in tem-

*In this article conversion is defined as the per cent of the gas oil in the feed which is catalytically cracked, with gas oil taken as fraction boiling above 400°F. E. P. gasoline.

The principal portion of a paper under the same title presented before the Division of Refining, American Petroleum Institute, Chicago, Nov. 15, 1945.

E. V. Murphree is connected with Standard Oil Development Co., New York. E. J. Gohr, H. Z. Martin, H. J. Ogorza'y and C. W. Tyson are with Esso Laboratories, Standard Oil Development Co., Elizabeth, N. J.

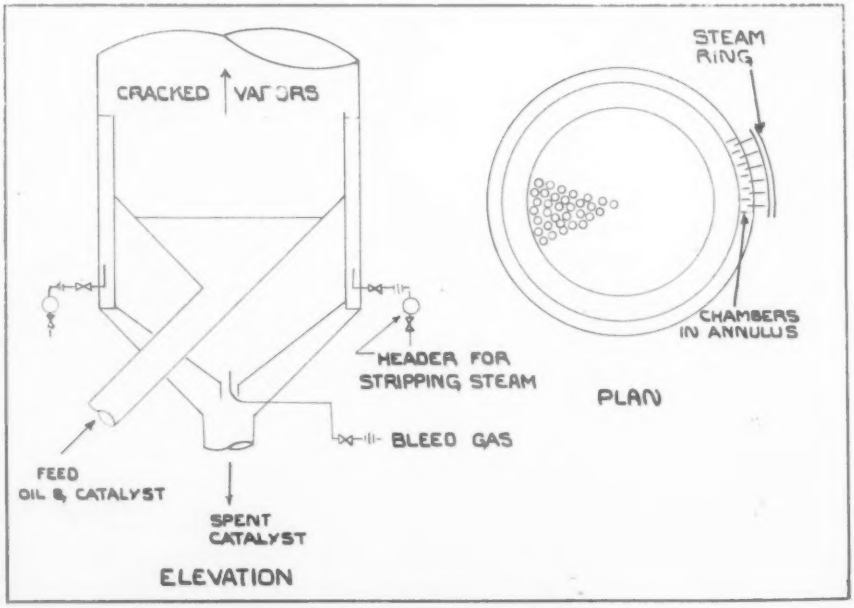

Fig. 1—Downflow Plant Stripper

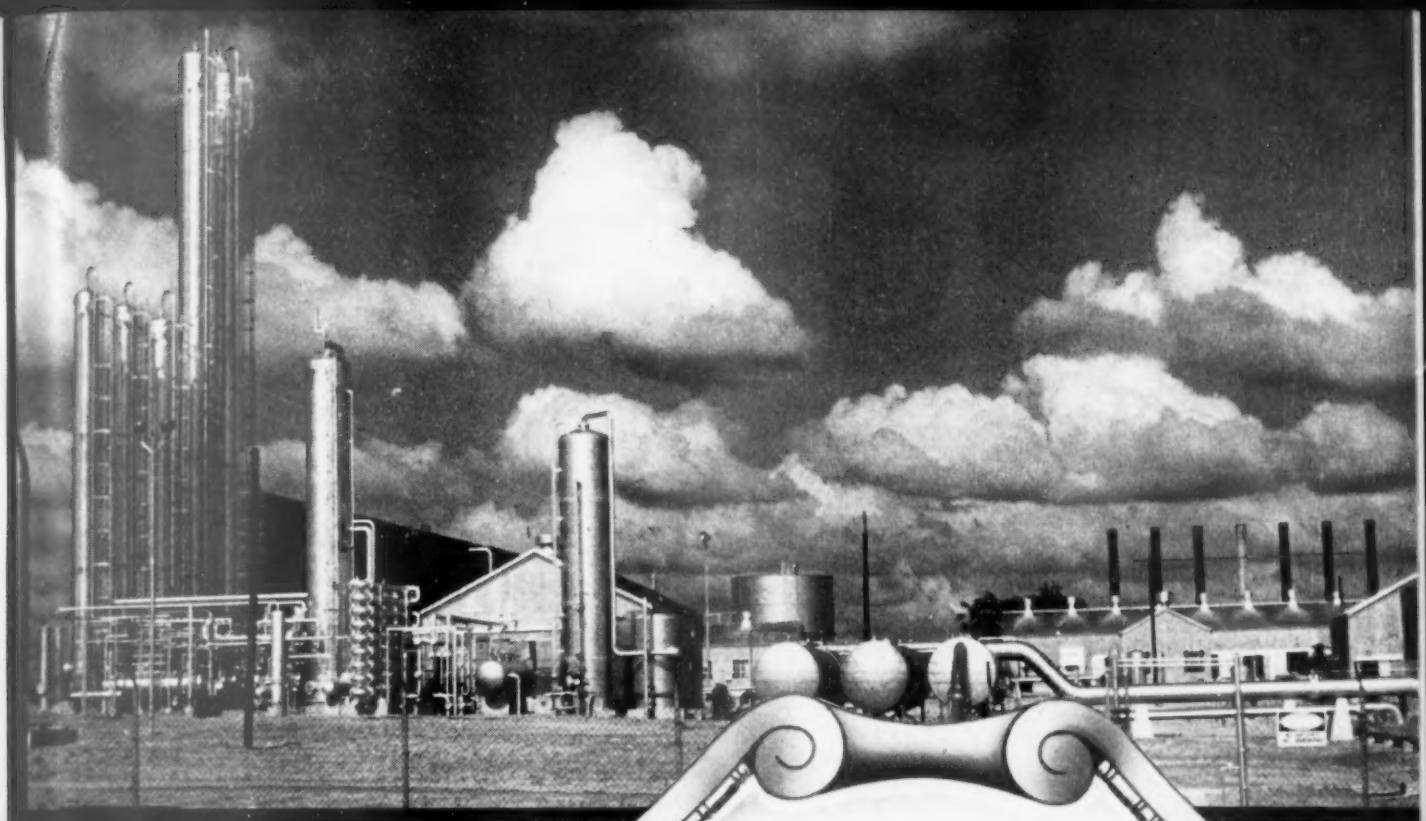

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TABLE 1—Humble Oil and Refining Co. Downflow Fluid Cracking Unit, Aviation Gasoline Operation

OPERATING DATA

	August 1944	June 1945
Regeneration Conditions		
Top Pressure, psig	1.8	5.0
Temperature, °F.	1055	1125
Air Blower Disch. Press., psig	14.0	11.8
Total Air Rate, SCFM	45,700	54,800
Oxygen in Flue Gas, Vol.-% (Dry)	2.4	1.2
Reactor Conditions		
Top Pressure, psig	10.0	17.5
Temperature, °F.	954	948
Catalyst-to-Oil Ratio	20.8	10.7
Oil Preheat Temperature, °F.	390	543
Gas Oil Conversion, Vol.-%	62.1	61.5
Total Reactor Steam, Lb./Hour	17,200	9,500
Capacities		
Carbon Burned, Lb./Hour	13,110	18,800
Oil Feed Rate, b/sd	16,400	28,000

TABLE 2—Humble Oil and Refining Co. Downflow Fluid Cracking Unit Aviation Gasoline Operation

YIELD AND QUALITY OF PRODUCTS

	August 1944	June 1945
Charge Stock		
Feed Rate, b/sd	16,400	28,000
Gravity, °API	30.2	29.9
Mid Boiling Point, °F.	625	623
Yields, Based on Feed		
Dry Gas, Wt.-%	12.0	10.4
Total C_4, Vol.-%	17.7	15.6
Butylenes	8.2	8.0
C_5-430°F. VT*	34.4	38.9
Cycle Oil	37.1	37.0
Carbon, Wt.-%	6.4	5.4
10 Lb. Cat. Cracked Motor Gasoline		
Yield, Vol.-% of Feed	36.2	40.8
b/sd	5940	11,400
ASTM Octane No., Clear	81.6	81.5
CFR-R Octane No., Clear	95.2	95.0
10 Lb. Cat. Cr. Gaso. Plus Polymer		
Yield, Vol.-% of Feed	46.8	49.9
b/sd	7670	14,000
ASTM Octane No., Clear	82.0	81.8
Plus 1.5cc. TEL	85.4	85.3
CFR-R Octane No., Clear	96.3	96.1
Plus 1.5cc. TEL	99.5	99.3
Excess Butanes, Vol.-% of Feed	6.4	4.3
b/sd	1050	1200

*Equivalent to debutanized 400° E.P. naphtha.

perature between the two vessels, or by a low catalyst rate and a high temperature difference. Therefore, for a given reactor temperature the catalyst-to-oil ratio may be decreased by raising the regenerator temperature.

Through operating experience it has been determined that the regenerators of commercial plants can be operated satisfactorily in the range from 1100 to 1150°F. All early regeneration was carried out at 1050 to 1075°F. A typical example showing the effect of an increase in regeneration temperature on catalyst-to-oil ratio and carbon yields follows:

Renegerator Temp., °F.	1050	1150
Reactor Temp., °F.	950	950
Oil Preheat Temp. °F.	430	560
Catalyst-Oil Ratio	23	10
Conversion, Vol.-%	62	62
Carbon on Feed, Wt.-%	6.2	5.3

Under conditions of operations in which regenerating capacity is limiting, as is frequently the case, it is evident, as in the above example, that the fresh feed charge capacity can be increased 15-20% by reason of the reduction in carbon yield at the lower catalyst-to-oil ratio. It is necessary to supply more preheat in the oil feed to maintain the same cracking temperature because of the smaller amount of carbon burned per unit of feed.

Increasing Regeneration Capacity

The above-mentioned increase in regenerator temperature has increased the efficiency of renegeration due to its beneficial effect on burning rate. Also, for a given contact time in the regenerator a larger proportion of the oxygen may be utilized. In early operations more excess air was required and the oxygen concentration in the flue gases averaged 2.0 to 3.0%. High temperatures have brought this value down to about half the former amount, resulting in higher carbon burning capacity.

However, other important factors have entered into the improvement of regeneration capacity. Pilot plant test data had shown that catalyst entrainment in flue gases rising from the dense bed increased rapidly when normal gas velocity was exceeded. However, further increase in burning capacity without increase in gas velocity can be obtained by increasing the regenerator pressure.

The following tabulation of calculated figures shows how regeneration capacity can be increased by the means discussed above.

Regeneration Press., psig	0.5	5.0
Regenerator Temp., °F.	1050	1125
Air Rate, SCFM	45,000	55,000
Oxygen in Flue Gas, Vol.-% (Dry)	2.4	1.2
Carbon Burning Capacity, Lb./Hr.	13,000	16,900

Thus a gain in carbon burning capacity of 30% is attainable in the above example. The values presented above were estimated on the basis of no change in hydrogen-to-carbon ratio in the coke carried to the regenerator. However, the improved stripper reduces the ratio such that an additional gain of 15-20% in carbon burning capacity is possible due to the fact that less oxygen is diverted to the combustion of hydrogen.

Except for the stripper improvements only minor equipment changes, such as rearrangement of fractionator bottoms heat exchangers in boiler and feed-preheat service, are required to take care of the increased capacity. Increases in velocity in the reactor and fractionator tower are avoided by raising the pressure on this equipment.

Representative Plant Data

A concrete illustration of the results obtainable by the methods discussed above is available in operating data from the downflow Fluid catalyst plant of the Humble Oil and Refining Co. Table 1 shows the operating data from this plant for the months of August, 1944 and June, 1945. These are typical periods representing operation before and after installation of the improved stripper. On the regeneration side (a) the regenerator pressure has been increased from 1.8 to 5.0 psig, (b) the temperature from 1055°F. to 1125°F., (c) the blower discharge pressure lowered from 14.0 to 11.8 psig and (d) the oxygen concentration in the flue gas has decreased from 2.4 to 1.2%. The resulting increase in air rate and in oxygen utilization, combined with the effect of the improved stripper on hydrogen content of the coke, made possible a 43% increase in carbon burning capacity, that is, from 13,110 to 18,800 lbs./hr.

On the reactor side it will be observed that, (a) although there is little difference in catalytic gas oil conversion between the two sets of data, the improved stripped aided by a decrease in catalyst-to-oil ratio reduced the carbon yield from 6.4% to 5.4%; (b) the reactor temperature was maintained approximately con-

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stant by reason of the higher oil inlet temperature and (c) the reactor gas velocity was kept at a reasonable level by an increase in pressure from 10 to 17.5 psig and also by a decrease in process steam. Thus it was possible to increase the plant feed capacity from 16,400 to 28,000 b/sd with little change in the proportion of the gas oil cracked to lighter products.

Table 2 shows the yields obtained. The improved product distribution shown by the recent data may be partly due to the lower amount of steam used. It has been found that steam affects some of the light hydrocarbon yields. Thus less dry gas and butanes are formed, and a larger proportion of the cracked products are found in the motor gasoline range. However, a small part of the increased gasoline yield is due to a higher (4.0% vs. 2.0%) naphtha concentration in the feed.

In Table 2 there are also summarized the production rates and octane numbers of 10 lb. catalytically cracked gasoline and also of 10 lb. motor gasoline based on non-selective polymerization of all recoverable propylene and butylenes and pressuring of the gasoline with catalytic butanes. It will be observed that the production of gasoline has increased 82% with little or no loss of quality. Also, in spite of the lower yield of butanes in the recent operation, the volume of excess butane available after pressuring the gasoline mixture is slightly greater than that for the early operation.

Capacity Ultimately Attainable

In the mechanical design for the first commercial Fluid catalytic cracking plants it was necessary to make allowance for the possible effects of high temperatures and erosion on the life of the vessels and lines. Since experience has shown that the high temperatures and erosion can be easily controlled within limits which make the original allowances conservative, it is possible to take advantage of this overdesign by operation at even more severe conditions than is presently done.

In these plants the mechanical strength of the regenerator limits the system pressure which can be used. Therefore the ultimate capacity of the plant is set by the amount of air which can be utilized at normal gas velocity in the top of the regenerator at this limiting pressure. In these figures we have taken 12.5 psig as the maximum pressure obtainable, although preliminary investigations now indicate that further increase may be possible. Table 3 shows the estimated plant capacity based on the 12.5 psig regenerator top pressure. Under these conditions the carbon burning capacity is increased about 20% above that attainable with a 5.0 psig regenerator pressure and is over 70% higher than the design value.

Although the yields are estimated for motor gasoline operation, that is, at 50% conversion, and are not strictly comparable with the previous data quoted above, which were at higher conversions primarily for production of aviation gasoline components, a comparison is made in Table 4 with the data of the low and high capacity runs at the Humble plant. It will be observed that there is a further possible increase in feed capacity to 42,000 b/sd. The daily motor gasoline plus polymer production is increased 152% and 38% above those of the low and high feed rate cases, respectively.

Due to the less severe conditions which are optimum for motor gasoline production, a lower butanes yield is obtained and all of it is needed for pressuring the gasoline. Also, the octane numbers of the resulting blends are slightly lower than those from the higher conversion operations.

To attain these expanded capacities some changes must be made in certain parts of the equipment. The most important of these are the installation of new air compression equipment, spent catalyst stripper alterations, reinforcing of catalyst recovery equipment, installation of a preheat furnace, and increasing the exchanger surface and pumping facilities in the fractionation section. However, the cost of these changes is relatively small when expressed as dollars per barrel of incremental feed capacity. This figure is estimated to be less than $100 per b/sd of charge stock.

It is believed that further improvements in Fluid operation are possible. Additional studies are being carried out to determine the factors which affect stripping and carbon deposition. That improvements in carbon-conversion relationship are possible in commercial plants has been indicated by the results of pilot plant tests. The results of these and other studies should add to the advantages of the use of Fluid catalytic cracking in the refining of petroleum.

TABLE 3—Expanded Plant Capacity Compared With Previous Operations

OPERATING CONDITIONS

	August 1944	June 1945	Expanded Operation
Regenerator Conditions			
Top Pressure, psig	1.5	5.0	12.5
Temperature, °F.	1055	1125	1100
Blower Discharge Press., psig	14.0	11.8	22
Total Air Rate, SCFM	45,700	54,800	72,500
Oxygen Conc. in Flue Gas, Vol.-% (Dry)	2.4	1.2	2.0
Reactor Conditions			
Top Pressure, psig	10.0	17.5	22
Temperature, °F.	954	948	950
Catalyst-to-Oil Ratio	20.8	10.7	9.5
Oil Preheat Temp., °F	390	543	675
Gas Oil Conversion, Vol.-%	62.1	61.5	50
Capacities			
Carbon Burned, Lb./Hour	13,110	18,800	22,500
Oil Feed Rate, b/sd	16,400	28,000	42,000

TABLE 4—Expanded Plant Capacity Compared With Previous Operations

YIELD AND QUALITY OF PRODUCTS

	August 1944	June 1945	Expanded Operation
Feed Rate, b/sd	16,400	28,000	42,000
Yields, Based on Feed			
Dry Gas, Wt.-%	12.0	10.4	7.2
Total C_4, Vol.-%	17.7	15.6	10.2
C_5-430°F. VT	34.4	38.9	36.5
Cycle Oil	37.1	37.0	48.0
Carbon, Wt.-%	6.4	5.4	4.1
10 Lb. RVP Cat. Cracked Motor Gasoline			
Yield, Vol.-%	36.2	40.8	38.4
b/sd	5940	11,400	16,100
ASTM Octane No., Clear	81.6	81.5	81.0
CFR-R Octane No., Clear	95.2	95.0	94.6
10 Lb. RVP Cat. Cr. Gaso. Plus Polymer			
Yield, Vol.-%	46.3	49.9	46.0
b/sd	7670	14,000	19,300
ASTM Octane No., Clear	82.0	81.8	81.5
Plus 1.5 cc. TEL	85.4	85.3	85.0
CFR-R Octane No., Clear	96.3	96.1	95.5
Plus 1.5 cc. TEL	99.5	99.3	99.0
Excess Butanes, Vol.-% of Feed	6.4	4.3	0
b/sd	1050	1200	0

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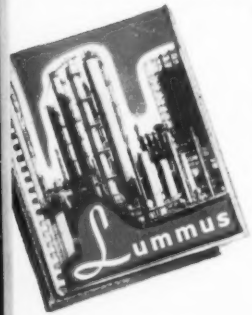

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A P I

Liquid-Charge Technique In TCC Processing

By T. P. Simpson, S. C. Eastwood and H. G. Shimp

An adaptation of the TCC process, called "liquid charge technique" for the catalytic cracking of heavy petroleum charge stocks is described.

The reactor used is the concurrent solid-bed downflow type with provision for introducing the feed at the top and removing the cracked products from the bottom. The charge may comprise total liquid or mixed liquid-vapor feed. The catalyst is the same used in the present conventional vapor-phase operations.

Yields of motor gasoline of 45 to 60% are typical, with 20 to 30% of distillate fuel oil and 10 to 20% of heavy fuel. The motor gasolines have CFR Motor Method octane ratings of 77-82 with good lead susceptibility.

Studies on a number of stocks show that catalyst-to-oil ratios of 1.8 to 4.0 by volume are adequate to achieve the desired conversion. Charge stocks should be below about 4% by weight Conradson carbon residue to maintain coke laydown at reasonable levels. Deasphalting of heavy asphaltic stocks greatly reduces the coke laydown and results in improved yields of motor gasoline.

THE catalyst flow system for liquid-charge technique is essentially the same as for vapor-phase operation, although the rate of catalyst circulation may in some cases be higher. Thus charge stock containing as much as 50% liquid when injected into the reaction chamber can be processed satisfactorily when the equivalent of 100 to 150 tons of catalyst per hour per 10,000 b/d of oil charge are circulated.

On the other hand, when very heavy charge stocks are processed, which may be almost 100% liquid when injected into the reactor, it has been found desirable to increase the catalyst circulation rate to as much as twice that for vapor-phase operation in order to maintain the catalytic system at an efficient operating level. It should be realized, however, that, even when processing very heavy charge stocks, the catalyst-to-oil ratios utilized are remarkably low.

The determination of optimum catalyst circulation rate with liquid-charge technique depends on a number of factors:

First, in order to satisfy heat balance requirements for the reactor, a certain minimum catalyst-to-oil-ratio must be employed with very heavy stocks. This may be as much as twice that required for vapor-phase operation.

Second, when heavy stocks are charged, particularly close-cut fractions, the ease with which such fractions are cracked results in a high level of conversion to useful products. This, of course, is highly desirable from the standpoint of economic considerations. Such operations generally result in greater coke laydown than is normal with light-stock cracking at somewhat lower conversions, and higher catalyst-to-oil ratios are frequently helpful in maintaining the catalyst mass at a satisfactory activity level.

Third, it is desirable to maintain the coke distribution on the catalyst within desired limits to facilitate the operation of the regenerating kiln. Thus, a plant operating on a light stock at a lower conversion level may circulate 100 tons of catalyst per hour per 10,000 b/d of oil charge with a resultant coke deposit of 5,000 lb per hour, or 2.5% by weight of the catalyst mass. Such a unit would employ a 10-zone regenerating kiln.

A 10,000 b/d unit, charging heavy liquid for high conversion operation, might form in the neighborhood of 10,000 lb of coke per hour when 200 tons of catalyst per hour are circulated to maintain conversion at the desired level. Thus, in the latter case, there would be twice the weight of coke to burn, but the per cent (2.5% by weight) of coke deposited on the catalyst mass would be the same, and the number of zones in the kiln would be the same as for the lighter-oil operation. This comparison is, for the sake of brevity, somewhat simplified, but it serves adequately to demonstrate the point in question.

The reactor used for liquid-charge technique is the concurrent solid-bed downflow type. Reactors of this type have been used in commercial vapor-phase operations, although most of the units now in operation use countercurrent upflow of vapors—the flow of catalyst being downward by gravity in either case. Without attempting to compare the merits of concurrent and countercurrent reactors, it will suffice here to state that concurrent flow has several advantages when liquid charge is employed, and has been adopted as the standard type for this technique. Two principal problems are involved in charging liquid to such a system: 1, introducing the liquid onto the catalyst in uniform fashion; 2, removing the vapors from the catalyst mass at a point near the bottom of the reactor. The latter problem has been fully developed and proved on concurrent-flow vapor-phase reaction systems, and the same methods will be employed in the liquid-charge systems.

Basically, these vapor collectors are simply inverted troughs which are assembled in the form of a grid covering the cross-section of the reactor. Catalyst flow passages are provided between the troughs, and the vapors are released from the catalyst in the free space under the open side of the trough, and they then flow out through a side outlet to the fractionating section of the unit. Gas-collecting systems operating on this same principle are also employed successfully for collecting flue gas in numerous operating kilns in existing TCC units.

Fig. 1 is a diagrammatic sketch showing a general layout of a concurrent-flow vapor-collector grid.

The liquid distributing system at the top of the reactor has been thoroughly tested and demonstrated in pilot-plant and test model units. Tests of several months or more have been made without plugging or coking of the distributing elements employed.

Experimental work has shown that the catalytic reaction starts and proceeds extremely rapidly the instant the spray meets the catalyst. For example, it has been demonstrated that, in cracking a 25% Mid Continent crude residuum, about 75% of the charge is converted to material having a lower boiling range than the inital boiling point of the charge stock at a point representing only 12% of the total path through the reaction

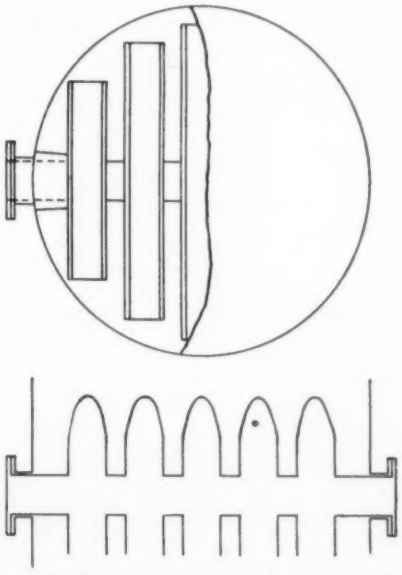

Fig. 1—Diagrammatic sketch showing a general layout of a concurrent-flow, vapor-collector grid

The accompanying is the principal portion of a paper under the same title presented before the Division of Refining, American Petroleum Institute, Chicago, Nov. 15, 1945.

Authors T. P. Simpson and S. C. Eastwood are with the Research and Development Laboratories, Socony-Vacuum Oil Co., Inc., Paulsboro. N. J. H. G. Shimp is with Houdry Process Corp. of Pennsylvania, Marcus Hook, Pa.

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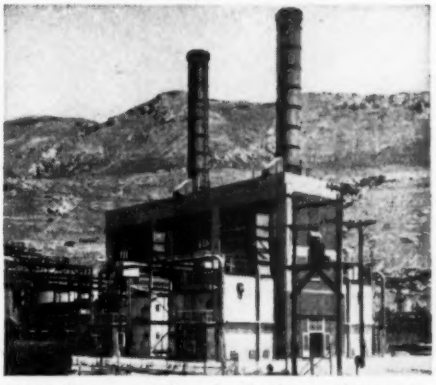

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TABLE 1—Properties of Typical TCC Liquid Charge Stocks

	Deasphalted 15% East Texas Residuum	25% Mid Cont. Residuum	Kan. Crude Vacuum Distillate	Wide-cut East Texas Flash Distillate
Gravity, deg API	23.2	21.2	22.3	26.4
Pour point, deg F	>120	85	110	>120
Sulfur, % by weight	0.39	0.46	0.61	0.38
Aniline No., deg F	234	220	205	207
Kinematic visc. at 210 deg. F	26.4	34.8	13.8	8.0
Conradson carbon resid., %	1.6	4.5	1.3	0.9
Vacuum-Assay Distillation in Deg F:				
	817	798	767	489
5-per cent point	933	831	808	631
10-per cent point	961	855	822	668
20-per cent point	992	881	840	729
30-per cent point	1,009	903	860	769
40-per cent point	1,032	940	880	810
50-per cent point	1,060	990	919	847
60-per cent point	1,106	1,020	950	888
70-per cent point	.....	.....	981	933
80-per cent point	.....	.....	1,029	999
90-per cent point	.....	.....	1,080	1,069
End point (approximate)	.....	.....	1,160	1,130
Recovery at 1,000 deg. F, %	24	53	74	81

zone. Similarly at this point about 70% of the ultimate gasoline formation has occurred, and only 0.7% of the original feed can be accounted for as residual oil on the catalyst. These results are mentioned at this point simply to emphasize the extremely rapid conversion which occurs at the inlet zone of the reactor, and a more complete discussion of the progressive conversion throughout the reactor will be given later.

The liquid-charge technique can be employed in many ways: for example, either total liquid or liquid vapor feeds may be charged directly to the reactor section, or alternatively vapor and liquid may be introduced separately at the top of the reactor—depending upon the flexibility required in overall refinery operation.

As to the commercial status of liquid-charge technique, it should be pointed out that commercial tests were delayed due to the necessity for keeping all TCC units on full production on the aviation-gasoline program during the war. Today, one existing TCC unit is being converted for liquid-charge operation, and will be in operation shortly. A second entirely new unit is under design, and should be erected during the coming year.

Processing Results

Typical Charge Stocks and Catalysts

Liquid-charge technique has been studied in the pilot plant on a wide range of charge stocks, varying from medium-boiling-range gas oils with their 50% points at 700 F, to an asphaltic Duo-Sol tar extracted in the solvent refining of lubricating-oil stocks. Physical properties of 4 typical stocks on which considerable experimental work has been conducted are shown in Table 1. These comprise deasphalted 15% East Texas residuum, 25% undeasphalted Mid Continent residuum, Kansas crude vacuum distillate, and a wide-cut East Texas flash distillate. It will be noted that none of these stocks would be considered as suitable for vapor-phase TCC operation due to their high boiling range—the per cent distilled at 1,000 F ranging from 24% for the deasphalted 15% East Texas residuum to 81% for the wide-cut East Texas flash distillate.

Catalyst for liquid-charge operation may be synthetic bead, synthetic pellets, or pelleted clay; they are the same as those used in present conventional TCC vapor-phase operations. Selections of catalyst for a given project will follow the same principles applicable to selecting catalyst for vapor-phase operations.

In general, the yields of motor gasoline, coke, and heavy fuel oil are higher,

TABLE 2—Yields and Properties of Products from TCC Liquid Feed Cracking Various Stocks Over 30 Activity-Index Clay Catalyst

Stock:	Deasphalted 15% East Texas Residuum			25% Mid Continent Residuum			Kansas Crude —Vacuum Distillate—			Wide-cut East Texas Flash Distillate	
Product:	*Motor Gasoline[1]	Light Fuel Oil	Heavy Cycle Stock	*Motor Gasoline[2]	Light Fuel Oil	Heavy Cycle Stock	*Motor Gasoline[3]	Light Fuel Oil	Heavy Cycle Stock	*Motor Gasoline[4]	Catalytic Gas Oil
Yield, per cent by volume	53.3	21.7	12.7	47.5	20.0	23.6	49.0	23.6	14.6	53.3	37.2
Gravity, deg API	60.0	26.9	14.4	61.1	26.4	18.5	60.7	23.8	11.4	57.5	21.0
Reid vapor pressure, lb	10.1	....	....	9.8	....	....	9.8	....	....	9.7	....
Acid heat, deg F	116	....	....	156	....	....	129	....	....	156	....
Induction period, hrs—min	15:45	....	....	8:00	....	....	13:20	....	....	....	....
Sulfur, per cent by weight	0.033	....	....	0.024	....	....	....	....	....	0.04	0.33
Aniline No., deg F	102	91	142	95	90	159	85	67	160	....	116
Pour point, deg F	....	<—35	85	....	<—35	80	....	—30	80	....	....
Distillation in Deg F:	**ASTM**	**ASTM**	**ASTM**	**ASTM**	**ASTM**	**Vacuum-Assay**	**ASTM**	**ASTM**	**Vacuum-Assay**	**ASTM**	**ASTM**
Initial boiling point	90	432	622	102	450	669	86	422	670	102	460
5-per cent point	104	462	652	116	476	694	108	454	690	120	495
10-per cent point	113	468	668	126	482	710	120	460	693	136	504
20-per cent point	134	477	684	144	490	723	144	470	703	161	525
30-per cent point	164	486	694	170	501	740	170	482	726	188	550
40-per cent point	199	499	702	200	510	767	200	496	741	222	570
50-per cent point	236	512	712	234	520	796	233	512	752	236	590
60-per cent point	266	531	724	262	532	823	260	529	770	262	612
70-per cent point	295	543	734	292	548	853	288	547	792	298	640
80-per cent point	326	564	748	322	568	890	317	568	820	330	680
90-per cent point	357	587	...	356	588	940	351	592	914	365	720
End point	389	612	...	388	618	...	397	624	943	408	732
Recovery, % by vol.	97.5	99.0	...	98.0	99.0	....	98.0	98.5	at 93% Cracked	98.0	Cracked
Loss, % by vol.	1.5	....	....	1.1	....	....	1.0	....	....	1.0	....
Octane No.:											
CFR motor-method:											
Without TEL addition	77.4	....	....	78.2	....	....	78.4	....	....	79.0	....
With 1 ml per gal. TEL	82.9	....	....	82.7	....	....	82.8	....	....	83.2	....
With 3 ml per gal. TEL	85.4	....	....	84.8	....	....	84.7	....	....	....	....
CFR research-method:											
Without TEL addition	88.2	....	....	89.2	....	....	90.4	....	....	91.1	....
With 1 ml per gal. TEL	93.0	....	....	93.6	....	....	94.5	....	....	94.9	....
With 3 ml per gal. TEL	95.2	....	....	96.3	....	....	96.9	....	....	....	....

*Motor Gasoline (10 lb. Reid vapor pressure; 90% point at [1] 357°F, [2] 356°F, [3] 351°F, [4] 365°F).

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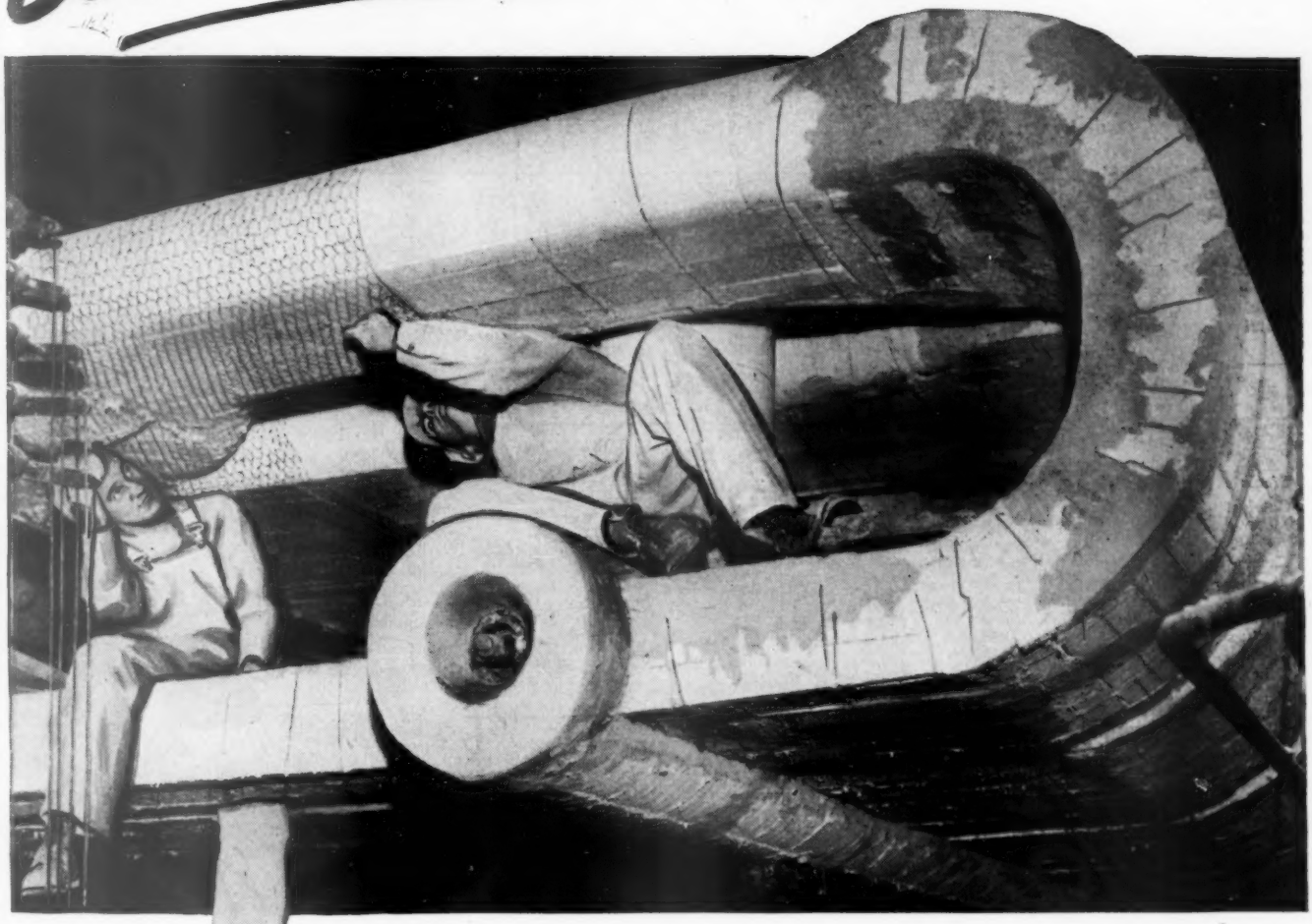

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TABLE 3—Typical Operating Conditions and Yields

Stock:	Deasphalted 15% East Texas Residuum	25% Mid Cont. Residuum	Kansas Crude Vacuum Distillate	Wide-cut East Texas Flash Distillate
Catalyst:	30 AI* clay	30 AI clay	30 AI clay	30 AI clay
Operating conditions:				
Oil inlet temperature, deg F	825	906	872	850
Catalyst inlet temperature, deg F	1,000	1,029	1,105	1,000
Average reactor temperature, deg F	870	915	926	920
Space velocity, V/V/hour	0.72	0.99	0.72	0.96
Catalyst-to-oil ratio, volume	5.2	4.0	3.8	4.4
Steam, per cent by weight of charge	5.4	5.1	5.0	10.6
Reactor pressure, psi (gage)	10	10.5	11	10
Yields:				
Motor gasoline (10 lb Reid vapor pressure; 90% point at 356 F), % by volume	53.3	47.5	49.0	53.3
Excess C_4 above 10 lb Reid-vapor-pressure motor gasoline, % by volume	9.9	5.9	8.0	7.7
Catalytic gas oil, % by volume	34.4	43.6	38.2	37.2
Liquid recovery, % by volume	97.6	97.0	95.2	98.2
Dry gas (C_3 and lighter), % by weight	8.2	7.0	9.5	7.0
Total coke deposit, % by weight	8.0	8.5	7.0	6.4
Total coke deposit, pounds per hour on 10,000-b/d feed	10,700	11,460	9,420	8,470

*AI = activity index.

TABLE 4—Effect of Catalyst-to-Oil Ratio

Stock:	Wide-cut East Texas Flash Distillate			
Catalyst-to-oil ratio, volume	1.9	2.9	4.6	6.0
Motor gasoline (10 lb Reid vapor pressure; 90% point at 365 F), % by volume	40.9	45.2	51.4	43.9
Excess C_4 cut above motor gasoline, % by volume	3.2	6.0	11.3	14.5
Catalytic gas oil, % by volume	56.5	47.7	33.1	19.2
C_3-free liquid recovery, % by volume	100.6	98.9	95.8	77.6
Dry gas (C_3 and lighter), % by weight	4.4	6.7	9.3	20.5
Coke, % by weight	3.4	3.9	7.1	13.2
Coke, pounds per hour on 10,000 b/d feed	4,500	5,120	9,220	17,350

and the yield of distillate fuel oil is lower, than from cracking light gas oils. Yields of motor gasoline of 45 to 60% by volume, of distillate fuel oil of 20 to 30% by volume, and of heavy fuel oil of 10 to 20% by volume are typical. Representative yields and operating conditions for processing the 4 charge stocks described hereinbefore over clay catalyst are presented in Table 2. At the operating conditions employed, the percentage of charge stock vaporized in the oil preheater varied from zero to about 50% for the deasphalted 15% East Texas residuum and wide-cut East Texas flash distillate, respectively.

Product Quality

The properties of catalytic products made from TCC cracking of heavy stocks are normal in all respects. Motor gasolines have excellent volatility with CFR motor method octane ratings of 77 to 82 and with CFR research octane ratings of 87 to 95. With the addition of 1 ml of tetraethyl lead per gallon, the octane ratings of the motor gasoline are raised 3 to 5 numbers by both methods of rating. Light distillate fuel oils (630-F end point) made from waxy high-pour-point charge stocks have a pour point below 0 F, usually in the range of —10 to —30 F. Heavy cycle stocks (made from charge stocks boiling predominately above 900 F) have their 50% points at 700 to 800 F and their 90% points below 900 F. Table 3 gives typical properties of motor gasoline, distillate fuels, and heavy fuel oils obtained from processing the charge stocks noted previously.

Operating Variables

The operating variables, and the range through which these variables have been studied, are as follows:

Oil inlet temp., deg F ..... 700 to 950
Catalyst inlet temp., deg F 900 to 1,100
Catalyst-to-oil ratio, vol ..... 1.8 to 6.0
Space velocity, V/V/hour* .. 0.4 to 6.0
Steam, per cent by weight ..... 5 to 10
Pressure, psi (gage) 10

*V/V/hour = ratio of the volume of liquid oil charged per hour to the apparent volume of catalyst in the reaction bed.

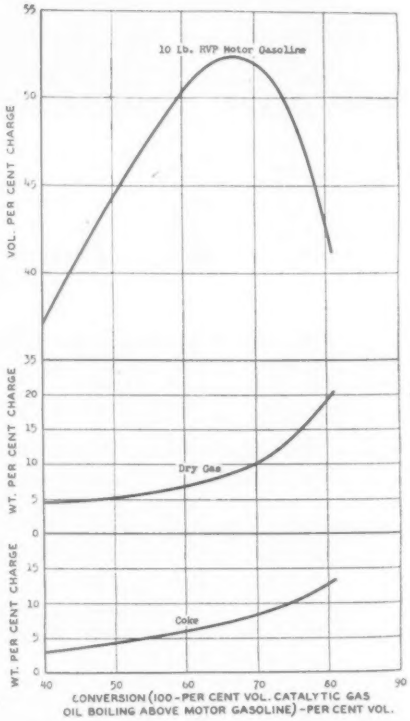
Inasmuch as the first three variables govern the heat supplied to the reactor, they exert a major effect on the severity of the cracking operation. It has been found that a total sensible heat input above 700 F equivalent to 400 to 450 Btu per pound of oil charge is required in the combined entering oil and catalyst streams to give an oil-free spent catalyst from the reactor when a stock is charged which has a substantial portion boiling above 900 F.

Catalyst-to-oil ratios need not be high in order to achieve the desired conversion with reasonable oil and catalyst inlet temperatures. Studies made on a number of stocks have proved catalyst-to-oil ratios in the order of 1.8 to 4.0 by volume to be adequate. For example, on the wide-cut East Texas flash distillate with oil and catalyst inlet temperatures of 850 and 1,100 F, respectively, the optimum catalyst-to-oil ratio appears to be between 3 and 4, as shown by the data in Table 4. At higher catalyst-to-oil ratios, such as 6.0, over-cracking occurs which results in a rapid increase in coke and gas with a loss in gasoline yield and liquid recovery.

Correlation of Product Yields on East Texas Flash Distillate

A correlation of product yields with conversion for all the data on the wide-cut East Texas flash distillate is shown in Fig. 2. This correlation is based on data in which the oil inlet temperature was varied from 700 to 850 F, the catalyst inlet temperature from 1,000 to 1,100 F, and the catalyst-to-oil-ratio from 1.8 to 6.0 by volume. This demonstrates the flexibility of this type of processing, as it reflects the interchangeability of the process variables to achieve a desired conversion level. On this stock, the maximum yield of 52.5% of motor gasoline, with a Reid vapor pressure of 10 lb and with a 90% point at 365 F, is obtained at about 67% conversion, with a yield of 9.0% by weight of dry gas (C_3 and the lighter) and 7.0% by weight of coke.

The progressive change in liquid-product yields with bed depth while cracking the 25% Mid Continent crude bot-


10 Lb. RVP Motor Gasoline
Dry Gas
Coke
VOL. PER CENT CHARGE
WT. PER CENT CHARGE
WT. PER CENT CHARGE
CONVERSION (100 - PER CENT VOL. CATALYTIC GAS OIL BOILING ABOVE MOTOR GASOLINE) - PER CENT VOL.

Charge stock: wide-cut East Texas flash distillate. Catalyst: 30 AI clay.

Fig. 2—Yield of motor gasoline, dry gas and coke as a function of conversion

TABLE 5—Product Yields at the 2-Ft and 17.5-Ft. Level of Catalyst Bed Depth

	2-Ft Level	17.5-Ft Level
Yields based on charge:		
Motor gasoline (10 lb Reid vapor pressure; 90% point at 356 F), % by volume	34.6	49.1
Excess C_4s, % by volume	4.2	6.6
Distillate fuel oil, % by volume	16.4	21.8
Heavy fuel oil, % by volume	44.6	17.7
Dry gas (C_2 and lighter), % by weight	4.2	8.3
Oil on catalyst, % by weight	0.7	0.2
Net carbon deposit, % by weight	5.8	8.9

TABLE 6—Effect of Conradson Carbon of Charge Stock on the Coke Laydown on Catalyst

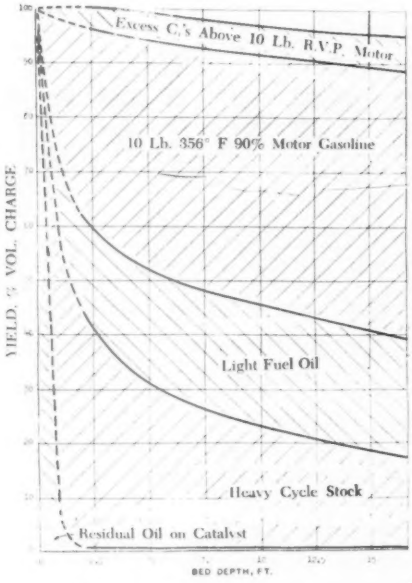
Stock	Deasphalted 15% East Texas Residuum	Mid Continent 25% Crude Bottoms	Duo-Sol Tar
Conradson carbon residue, % by weight	1.6	4.5	13.0
Conversion,* % by volume	57.4	57.4	57.4
Coke laydown, % by weight	6.5	10.5	28.0
Coke laydown, pounds per hour on 10,000-b/d feed	8,700	14,100	41,500

*Conversion 100 = minus per cent by volume of catalytic gas oil boiling above motor gasoline.

toms over 30-activity clay catalyst is shown in Fig. 3, with the results expressed in terms of equivalent bed depth for a 16-ft-diameter 10,000-b/d commercial reactor. Substantially all the liquid is cracked off the catalyst in the first 2 ft of bed depth; futhermore, 70% of the ultimate gasoline yield is obtained at this level, and the change in product distribution throughout the remainder of the reactor is relatively slow. Product yields at the 2 ft and 17.5-ft levels are shown in Table 5.

High Carbon Laydown

The relatively high carbon laydown associated with high-conversion liquid-charge technique on heavy stocks as compared to normal operation on lighter gas oils is due to the character of the charge rather than to the fact that the charge is a liquid when it contacts the catalyst. For example, on a stock which could be charged either completely as a vapor or as about 50% liquid there was no noticeable difference in carbon laydown or product distribution when the total heat input to the reactor was held the same.


Excess C4's Above 10 Lb. R.V.P. Motor
10 Lb. 356° F 90% Motor Gasoline
Light Fuel Oil
Heavy Cycle Stock
Residual Oil on Catalyst
YIELD, % VOL. CHARGE
BED DEPTH, FT.

Catalyst: 29 AI clay.
Catalyst-to-oil ratio: 2.9 W/W.
Oil inlet temperature: 900 deg F.
Catalyst inlet temperature: 1,025 deg F.
Steam: 5 per cent.

Fig. 3—Product distribution vs. bed depth for liquid-charge TCC cracking 25% Mid-Continent crude bottoms

TABLE 7—Comparable Data from Cracking Raw Residuum and Deasphalted Stock

	Raw East Texas Residuum	Deasphalted East Texas Residuum
Motor gasoline (10 lb Reid vapor pressure; 90% point at 356 F), % by volume	34.1	53.3
Excess C_4s above motor gasoline, % by volume	5.1	9.9
Distillate fuel oil, % by volume	22.1	21.7
Heavy fuel oil, % by volume	25.0	12.7
C_3-free liquid recovery, % by volume	86.3	97.6
Dry gas (C_2 and lighter), % by weight	7.1	8.2
Coke, % by weight	18.4	8.0
Coke, pounds per hour on 10,000 b/d feed	25,700	10,700

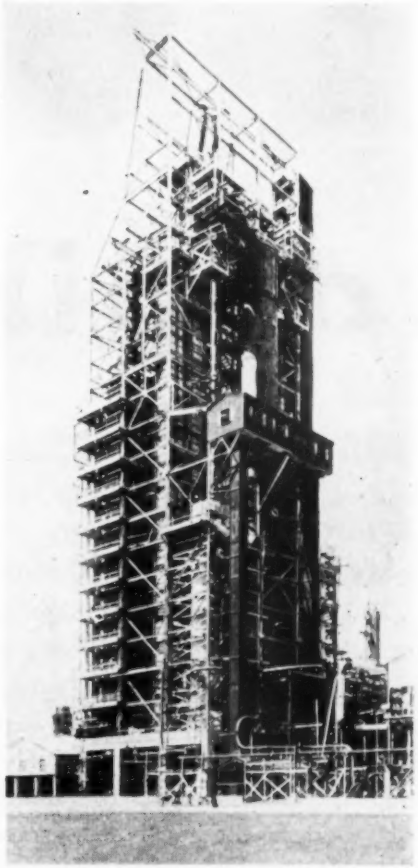
Reduced crudes or residuums should be deasphalted to give Conradson carbon residues below about 4% by weight before they are cracked in order to maintain the coke laydown at reasonable levels. The effect of Conradson carbon of the charge stock on the coke laydown is shown by the data in Table 6.

The advantage of removing asphalt from the charge prior to cracking is not only confined to considerations of carbon burning requirements, but also is reflected in greatly improved yields of motor gasoline for a given catalytic cracking capacity. This is illustrated by comparable data from cracking an 11.6% by-weight carbon-residue raw East Texas 15% residuum and a 1.6%-by-weight carbon-residue deasphalted East Texas 15% residuum, as shown in Table 7.

Deasphalting

Deasphalting may be accomplished by any conventional method such as vacuum distillation, flash distillation, or solvent deasphalting; selection of the process will depend on the economics for the particular installation under consideration. On low-carbon-residue crudes, where deasphalting may not be necessary from the standpoint of carbon laydown, it will, nevertheless, be necessary to give the charge to the catalytic unit some treatment to remove inorganic salts or other non-volatile materials which might be harmful to the catalyst.

The original TCC process and the liquid-charge technique are both developments of the Research and Development Laboratories of the Socony-Vacuum Oil Co., Inc., at Paulsboro, N. J. Their further development and engineering are being conducted by the latter concern in cooperation with the Houdry Process Corp. The TCC process, including the liquid-charge technique, is made available to the industry through licenses granted by the Houdry Process Corp.



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In 1936 Badger designed and supplied a crude topping and vacuum unit rated at 71,000 bbls. per day of crude charge. So satisfactory was the performance that three more were purchased in 1937, 1939 and 1945, respectively. Thanks to the close co-operation with the refinery technicians which Badger engineers always strive to achieve, these units have all consistently operated at up to 86,000 bbls. per day crude input with closer cutting than ever. BADGER KEEPS ON TOP.

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LICENSING AGENTS FOR THE TCC PROCESS AND THE HOUDRY CATALYTIC CRACKING PROCESSES

R-984

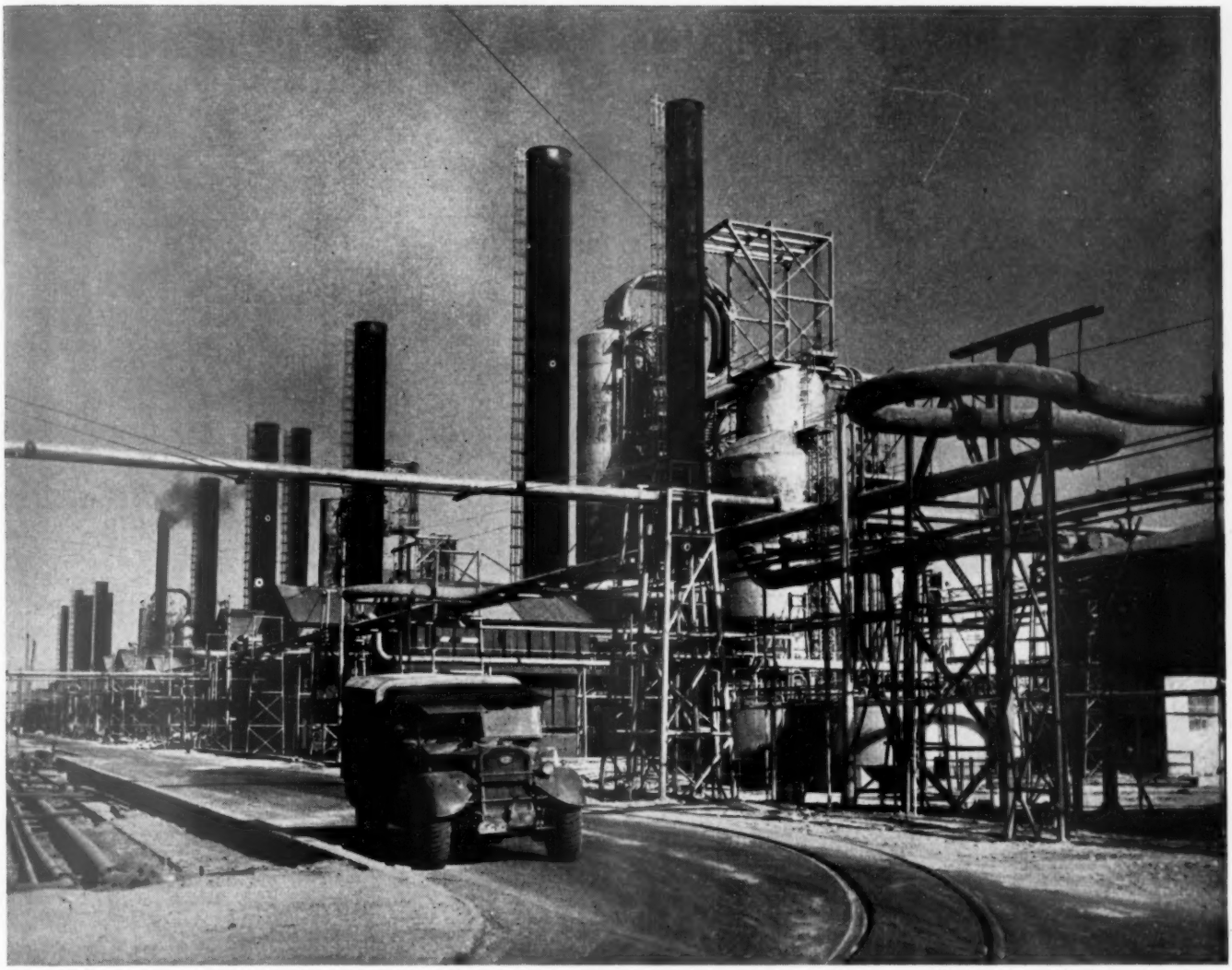

Photo courtesy Anglo-Iranian Oil Co.

The largest refinery in existence now operates four Badger-designed topping and vacuum units

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PROCESS ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM, PETRO-CHEMICAL AND CHEMICAL INDUSTRIES

Patent Trends in Petroleum Refining

By Peter J. Gaylor

Patent Attorney and Editor of "Technical Survey", Newark, N. J.

Nitro Hydrocarbons and Derivatives

Most readers are familiar with the various nitro derivatives of the lower hydrocarbons now being made in increasing quantities by Commercial Solvents and originally developed by Hass and his co-workers at Purdue. In recent years, Imperial Chemical Industries of Great Britain has been producing nitrogen tetroxide (N_2O_4) in commercial quantities and apparently is carrying on research on the utilization of this gas. Patents which have just been issued to this firm indicate a simple method for producing nitrohydrocarbons.

It will be recalled that the CSC process treats saturated hydrocarbons at high temperature with nitric acid in special alloy reactors. The I.C.I. workers found that vapor phase reaction gave low yields. In the case of ethylene and nitrogen tetroxide, reaction proceeds best at low temperature. For example, in U. S. 2,384,047, 1,2-dinitro ethane (NO_2CH_2—CH_2NO_2) melting at 39-40°C. and boiling at 135°C./5 mm. is produced by reacting the two components at around —10°C., even at atmospheric pressure. Although N_2O_4 freezes at this temperature, it still appears to react with the olefin. Care must be taken not to exceed the critical temperature of N_2O_4.

With the above process, the amount of ethylene used cannot be increased beyond 15-25% of that equivalent to the N_2O_4 without danger of spontaneous decomposition. Also, due to the danger of explosion, excess N_2O_4 is allowed to escape into the atmosphere rather than allow building up of pressure. By the use of the process disclosed in U. S. 2,384,048, the ratio may be increased and excess N_2O_4 may be recovered. This is accomplished by carrying out the reaction in the liquid phase in presence of oxygen. It is desirable to employ olefin free of alcohol or ether or other olefins.

Isobutylene also reacts with N_2O_2 to give 1,2-dintro-2-methyl propane. In U. S. 2,384,050, the I.C.I. prepares alpha nitro isobutene by reacting dinitro isobutane with an aliphatic alcohol according to the reaction:

$$(CH_3)_2C{\cdot}NO_2{:}CH_2NO_2 + ROH \rightarrow (CH_3)_2C{:}CHNO + RONO + H_2O$$

The firm has also found that polymerized nitroethylene may be produced by reacting beta nitroethyl nitrate with a carbonate, bicarbonate, etc. in an aqueous medium (U. S. 2,384,049). A yield of around 50% (on the nitrate) of polymer is generally obtained in the form of a pale yellow powder.

It appears that I.C.I. is now in the process of preparing a number of interesting derivatives of nitrohydrocarbons.

Bead Catalysts

Socony Vacuum's patents on the so-called "T.C.C. synthetic beads" have issued as U. S. 2,384,942-5 and 2,384,-455. It will be recalled that the T.C.C. process employs a formed catalyst which moves countercurrent to the feed to be cracked. For example, in Fig. 1, the catalyst is dropped into cracking section 32 through valve 44 countercurrent to gas oil vapors entering at 42 and leaving at 43. The spent catalyst is dropped into hopper 51 from which it is picked up by elevator 34 and carried up to the top of the regenerator 30 where it is regenerated by blowing air in at 37 and drawing off flue gas at 38.

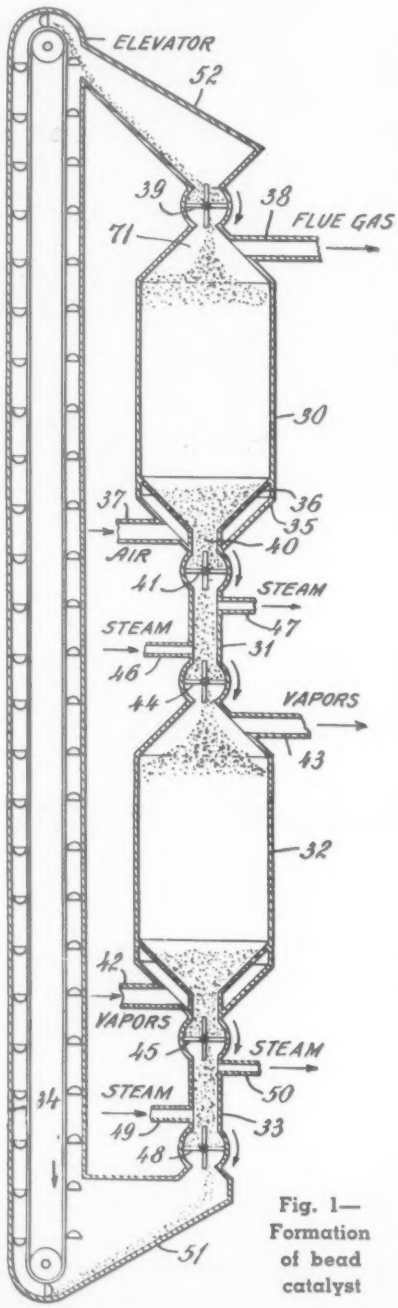

Fig. 1—Formation of bead catalyst

The present patents involving the preformed synthetic catalyst beads involve the dropping of hydrosol catalyst globules into a body of fluid immiscible with water (such as oil) in which the globules assume a speroidal shape due to the surface tension at the interface between the sol and the medium. Gelling takes place in this region. Fig. 2 shows the apparatus employed. The sol is ejected through nozzle 10 into a column of oil 11 about 8 ft. in depth. By the time it reaches the aqueous layer 12 at the bottom of the tank, the sol has gelled into a sphere and the water floats off any oils adhering to its surface. The spherical pellets are then drawn off at 14.

One of the peculiar features attributed to these gel pellets is their transparency which is present only when silica is predominant. They are extremely hard and, due to this property and their smooth surfaces, they are capable of resisting losses by attrition and shock in handling for periods many times longer than the molded pellets heretofore employed.

The main claim of U. S. 2,384,942 is rather broad and covers:

"In a process for the manufacture of valuable hydrocarbon products by contacting reactants containing carbon and hydrogen with an inorganic sythetic gel, the improvement which comprises contacting said reactants at conditions of temperature and pressure suitable for the process with hard homogeneous porous dried particles of said gel bounded by smooth hard glossy surfaces consisting substantially of smooth curves and characterized by a high resistance to attrition loss, said particles having been produced by a process which comprises forming a hydrosol of inorganic oxide characterized by an inerent capacity to set to a hydrogel upon the lapse of a suitable period of time without addition to or subtraction from said gel of any sub-

Porocel is being produced in a new grade that offers many advantages to the refiner or chemist who is looking for an adsorbent, catalyst, or catalyst carrier of high natural purity and low cost. The silica content of this new Porocel is unusually low and the iron content is at a minimum —features made possible by a special bauxite ore.

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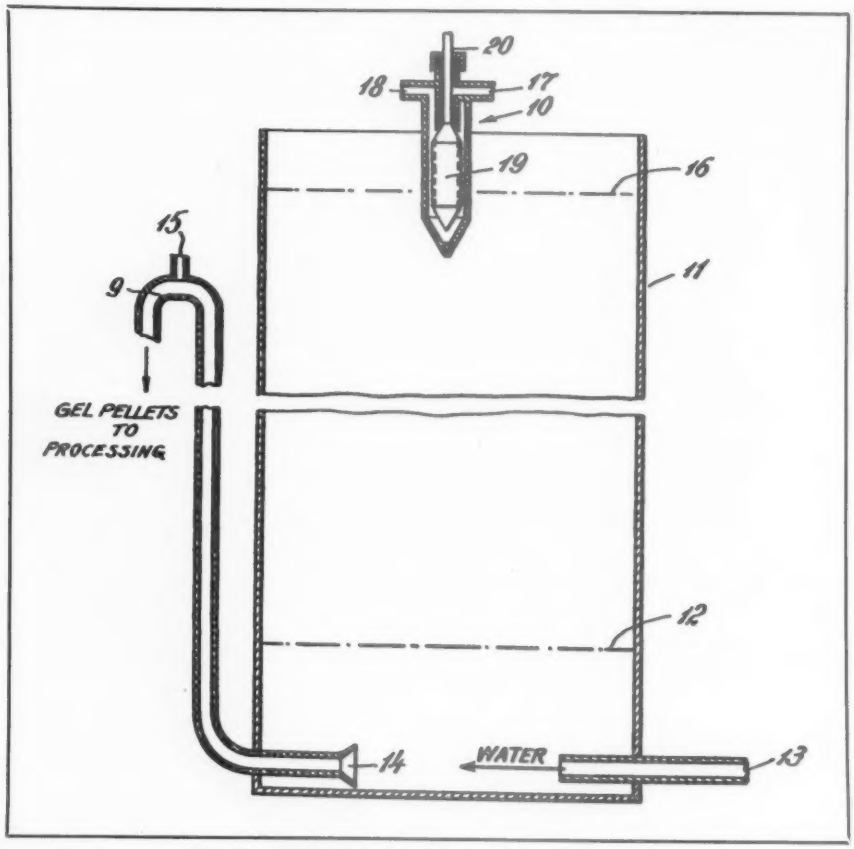

Fig. 2 — Apparatus used with present patent

stance, admitting said sol in the form of separate globules to a body of a fluid medium substantially immiscible with water in which said globules assume spheroidal shape due to surface tension at the interface between said sol and said medium, retaining said spheroidal globules in said medium until gelation occurs thus forming spheroids of hydrogel, effecting retention in said sol of substantially all the constituents of said sol until gelation occurs and drying the hydrogel spheroids."

U. S. 2,384,945 covers the incorporation of some air in the particles, presumably to reduce the weight of the particles.

A recent U.O.P. British Application (966/45) discloses the manufacture of silica-alumina spherical particles by first forming a silica sol, passing the sol in the form of droplets into a fluid suspending medium, regulating the pH of the sol and suspension time of the droplets set within the suspending medium into spheres of silica hydrogel, washing the silica spheres, drying, calcining and compositing them with alumina. A Houdry British Application (3334/43) disclosed a hot gas treatment for producing shaped catalyst particles from gels.

TABLE 1

Component	Normal B.P., °F.	Normal Volatility Relative to Vinylacetylene
Isobutane	+10.8	1.89
Isobutylene	19.2	1.53
Butene-1	20.7	1.498
1,3-butadiene	23.9	1.43
n-Butane	31.1	1.23
Butene-2 low (cis)	33.6	1.142
Butene-2 high (trans)	38.5	1.034
Vinylacetylene	41.2	1.00
Ethylacetylene	47.8	.895
Bi-acetylene	49.6	.870
Dimethylacetylene	81.0	.423

Vinyl Acetylene

The raw material for neoprene is vinyl acetylene, produced by controlled polymerization of acetylene. In the cracking of hydrocarbons at high temperatures, as in the production of ethylene, propylene, and butadiene, some vinyl acetylene is produced. In some processes, this compound is destroyed prior to recovery of the olefin or diolefin, since it involves an explosion hazard.

Some oil companies are now working on the recovery and utilization of vinyl acetylene. For example, Phillips Petroleum has obtained U. S. 2,382,603 of the recovery of vinyl acetylene in concentrated form from a C_4 stream from certain thermal cracking and catalytic dehydrogenation processes. Ordinarily, this compound is very difficult to separate since there is only a small differential in boiling points between it and the various hydrocarbons in admixture with it, as can be seen from Table 1. Also, an azeotrope exists between it and butenes-2.

Advantage is taken of the fact that the azeotrope is of minimum boiling point (i.e. below that of the vinylacetylene and butenes-2) for the separation, by distilling the azeotrope from the other C_4 acetylenes. A number of solvents have been found which selectively absorb vinylacetylene from the other C_4 hydrocarbons, so that it is possible to obtain vinylacetylene in purity of 95% or better. The solvents used are phenol, acetone, furfural, dimethyl formamide and methyl levulinate.

In the production of butadiene by pyrolysis of hydrocarbons, the C_4 fraction is usually extracted with ammoniacal cuprous acetate solution in which the diolefin is selectively absorbed. Acetylenes are also absorbed and afford an explosive hazard if they separate out as the copper acetylides. It has been found in Standard Oil Development Co.'s U. S. Patent 2,384,329 that these acetylides are very soluble in high ammonia or high amine solutions, thus making it possible to extract butadiene from C_4 cuts containing otherwise prohibitive quantities of acetylenes. The data indicate that at least 0.5 mole per liter of ammonia in excess of that required to solubilize the cuprous hydroxide present in dissolved form must be added, the copper content being at least 2 mols per liter.

Acrolein Compounds

One patent issued to the Battelle Memorial Institute discloses the use of tellurite and selenite catalysts for the oxidation of olefins to acroleins. In U. S. 2,383,711, an example is given on the oxidation of isobutylene with air at 230° C. in the presence of silver selenite, the temperature being gradually raised to 295°C. to maintain optimum activity. Under such conditions, about 30% of the olefin was converted to alpha methacrolein per pass with less than 1% destroyed to CO_2.

With a 90/10 air-propylene mixture, using silver selenite supported on asbestos and promoted with cupric oxide, 20% of the olefin was converted to acrolein per pass at 295°C., the amount burned to CO_2 being less than 0.6%. By adsorbing the acrolein on active charcoal, it is possible to recycle the gases (oxygen, rather than air, then being added?).

Selected Patents of the Month

U. S. 2,386,755 (Woodall-Duckham)—Separating aromatics from non-aromatic hydrocarbons by azeotropic distillation.

U. S. 2,386,769 & 71-4 & 7,224 (Socony)—Separating tert.-base olefins by converting to mercaptans.

U. S. 2,386,770 (Socony)—Purifying butadiene.

U. S. 2,386,778 (United Gas Improvement Co.) Fractionation control.

U. S. 2,386,784 (S. O. Indiana)—Isomerization.

Patent Trends

U. S. 2,386,798 (S. O. Ohio)—Recovery of HF-BF_3 catalyst.

U. S. 2,386,804 (Safety-Fuel Inc.)—Solidified normally liquid hydrocarbons.

U. S. 2,386,810 (Socony)—Silica gels.

U. S. 2,386,830-1 (Dow)—Continuous analysis of organic systems.

U. S. 2,386,846 (Socony)—Catalytic apparatus.

U. S. 2,386,867 (Nostrip Inc.)—Bitumen treating agent.

U. S. 2,386,927 & 83 (Phillips Petroleum)—Separating diolefins.

U. S. 2,386,931 (Phillips Petroleum)—Synthetic rubber production.

U. S. 2,386,934 (General Motors)—Olefin isomerization with concentrated HCl.

U. S. 2,386,941 (Petrolite)—Desalting oil.

U. S. 2,386,944 (Universal Oil Products)—Recovering hydrogen halide.

U. S. 2,386,947 (Phillips)—Catalytic dehydrogenation.

U. S. 2,386,952 (S. O. Ohio)—P-S containing cutting oils.

U. S. 2,386,957 (Universal Oil Prods.) dehydrocyclization of aliphatics.

U. S. 2,386,958 (Pittsburgh-Des Moines)—Spherical liquefied gas container.

U. S. 2,386,969 (Universal Oil Prods.)—Xylene from diethylbenzene.

U. S. 2,386,982 (Universal Oil Prods.)—Alkylation of aromatics.

U. S. 2,386,999 (Shell)—Allyl ester resins.

U. S. 2,387,024 (Shell)—Pressure vessel and support.

U. S. 2,387,026 (Phillips Petroleum)—Catalyst chamber.

U. S. 2,387,037 (Socony)—Hard resins.

U. S. 2,387,157 (Socony)—Emulsifiable petroleum products.

U. S. 2,387,162 (Phillips Petroleum)—Alkylation.

U. S. 2,387,170 (Cities Service)—Polyhydronaphthalene low temperature lubricant with E. P. agent.

U. S. 2,387,171 (Cities Service)—Refining petrolatum.

Brit. Appl. 5413/45 (duPont)—Polymers of tetrafluoro ethylene.

Brit. Appl. 6097/45 (Imperial Chemical Indus.) — Dichlorodifluoroethylene polymers.

Brit. Appl. 14581/43 (Shell)—Turbine lubes.

Brit. Appl. 216/43 (Std. Oil Dev. & Rohm & Haas)—Solvent extraction of oils.

Brit. 571,909 (Anglo-Iranian)—Aviation fuel.

Brit. 571,911 (Shell)—Isomerization.

Brit. 571,814 (Telegraph Const.)—Powdered polymerized hydrocarbons.

Brit. 571,829 (Wingfoot)—Cyanostyrene polymers.

Brit. Appl. 19821/43 (Shell)—Rubber-like copolymers.

Brit. Appl. 24840/44 (Shell)—Methylpentadiene polymerization.

Brit. 571,543 (Shell)—Toluene from petroleum.

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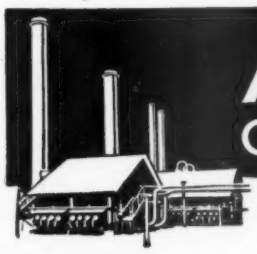

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New Design of Downspout for Bubble Trays Separates Liquid from Foam and Vapors

A RADICALLY new design of downspout for bubble trays in fractionating and absorption columns is described in a patent issued Sept. 25, 1945, to Clarence G. Gerhold, manager of the Riverside research and development laboratories of Universal Oil Products Co. The patent, U. S. 2,385,355, is assigned to UOP.

The principle utilized in the downspout of withdrawing fluid from the bottom of the liquid on the tray, it is claimed, avoids carrying down entrained vapors and foam. This is claimed to allow the use of smaller downcomers, thereby providing more efficient utilization of the bubble tray area. A possible result might thus be the use of smaller diameter towers. The new design is also said to eliminate the possibility of accumulations of sediment on the individual trays.

The new design comprises two conduits, one concentric in the other, provided with a system of ports and so arranged with reference to the trays as to maintain an effective head on the flow of liquid in the downspout.

In the new downspout, according to the patent claims, "a portion is utilized as an effective head to induce the flow of liquid from the bubble tray into the downspout whenever the height of the liquid level upon the tray rises above a certain predetermined point. When the liquid on the tray is below this predetermined point, only the height of liquid above the tray is effective as head for inducing flow into the downspout. The increased head effected by the novel arrangement of the downspout. . . . makes possible the use of smaller downspouts, thereby releasing more tray area for bubble caps.

"Also, by withdrawing fluid from the bottom of the liquid on the tray, less entrained vapors and foam must be carried by the downspout. In conventional downspouts this entrained vapors and foam presents a difficult problem and makes necessary the use of design factors which take into account the transportation of this foam from one tray to the next through the downspout and this results in relatively large size downspouts."

The new design of downspout is described as follows in the patent claim:

"Referring to Fig. 1, the main shell of the fractionating column is indicated by 1 and disposed therein are bubble trays 2 and 3. The bubble trays are securely attached to the fractionating column shell by welding or other suitable means. Conventional vapor risers and bubble caps 4 and 5 respectively are provided in the bubble trays, the bubble cap being secured by means of hold-down bar 6, which is attached to the wall of the fractionating column or to the bubble tray by bolts or other suitable means.

"Passing through tray 2 is an elongated conduit 7 which terminates a short distance above tray 3 to allow passing of fluid on to the latter. The upper end of conduit 7 is closed by means of cap 8, which is provided with a plurality of ports 9, the purpose of which will be later explained.

"Around the periphery of conduit 7 immediately above tray 2 are a series of ports 10 through which liquid may flow from above tray 2 into the conduit and thence down to tray 3. Concentrically disposed within conduit 7 is another conduit 11 which is open at both ends. The lower end of conduit 11 terminates a substantial distance below tray 2 but above the normal liquid level within conduit 7 which is indicated by broken line 12.

"The upper end of conduit 11 extends to a suitable distance above the normal liquid level on tray 2. The total area of ports 9 and 10 should preferably be at least as large as the cross-sectional area of the annular space between conduits 7 and 11 where they intersect the plane of tray 2.

"In operation, the downspout will function as follows: The flow of liquid down the column is normally at such a rate that ports 10 are insufficient to carry it all away from the tray when the liquid level is at a height indicated by broken line 13. In this case the effective head which governs the flow through ports 10 is indicated at h_1. Because the flow through ports 10 is less than the normal flow down the column, the liquid level on the tray will tend to build up until it reaches a height indicated by broken line 14.

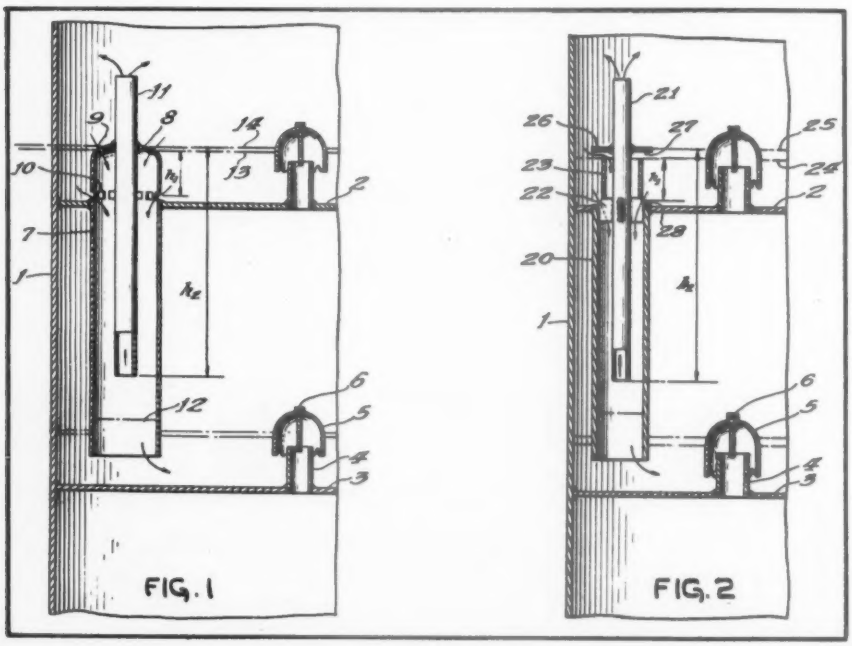
"When this occurs, ports 9 are closed, thus preventing the entry of vapors into the annular shaped portion of the downspout and the entire upper annular shaped portion of the downspout between conduits 7 and 11 from closure member 8 to the lower end of conduit 11 will fill with liquid. This will in turn change the effective head on ports 10 from h_1 to h_2 and will result in a considerable increase in flow from tray 2 into and down the downspout.

"By selecting suitable sized ports 9 and 10, this increased rate can be made considerably in excess of the normal flow of liquid down the column and will, therefore, cause the liquid level on tray 2 to return to the height indicated by broken line 13. When the liquid level again reaches the height indicated by broken line 13, ports 9 are uncovered, thus releasing the liquid in the upper portion of the downspout and changing the effective head on ports 10 to h_1.

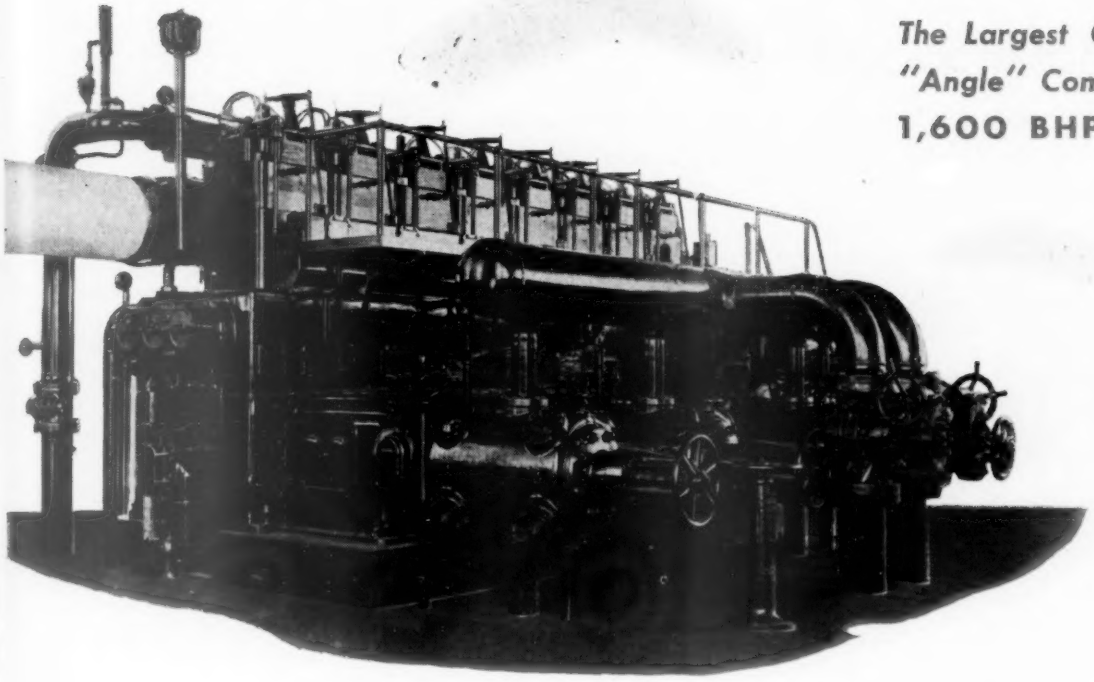
"This cycle of events will continually be repeated during the operation of the downspout and a liquid level on the tray will be maintained between the heights indicated by broken lines 13 and 14."

Fig. 2 shows a slightly different design, in which the cross-sectional area of the downspout at the tray level is limited to the combined area of the ports to increase the effective head.

The inner conduit in the downspout allows the return of vapors separated in the lower portion back to the vapor space above the tray.



New design of downspout for fractionating column bubble trays



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Corrosion Protection of Steel Pipe By Resin Baking Coatings

While Value of Phenolic Resins Was Earlier Recognized, Practical Means for Applying Them to Pipe Were Lacking Which are Now Believed Overcome through Induction Heating

RESULTS of test work carried on during the past five years on the protection from corrosion of steel pipe by resin baking coatings, together with the development of a practical method for applying such coatings by induction heating, have awakened new interest in this means of corrosion prevention.

Oil company material which might be so protected, both internally and externally, is said to include petroleum and natural gas line pipe, boiler tubes, heat exchanger and condenser tubes, among other items. The suggestion has been made that it might prove economical in many instances to coat existing installations, as well as new material. Robert J. Moore, Technical Coordinator, Bakelite Corp., New York, has presented a report on the use of resin baking coatings before the 1945 fall regional meetings of the Federation of Paint and Varnish Production Clubs.

"Where corrosion is the problem—not merely decoration—and where paint or varnish in the past have failed or have not even been attempted, there is great opportunity today for the protective coatings industry," Mr. Moore told his audiences. Following is a review of his report:

"While resin baking coatings for years had been extending their field of usefulness in industrial coatings, it was their solving of exacting coating problems during the war that really awakened the paint and varnish manufacturers to their unusual values.

"At the outbreak of the war alarming shortages of corrosion resistant metals made it necessary to revert to steel. The coatings industry was called upon to supply satisfactory protective finishes for steel, and in addition to solve additional coating problems never before confronted. With their utilization of the phenolic baking resins they were able to meet these requirements and to pass the severe and unusual specifications necessary to guarantee their procurement. Among these requirements the following few are mentioned:

"Corrosion resistant coating for the steel replacing brass for cartridge cases. The coating was required to withstand the rigors of storage, shipping and handling and the final fiery blast inside the gun breeches. It was required that the coating remain mirror-smooth and unbroken in the breech on firing, where the temperature frequestly reaches 600 F., withstanding the explosive expansion and contraction.

"Also the protective coatings for army food containers, portable gasoline tanks, ammunition boxes, many bomb parts, portable water tanks and metal buckles. A most unusual and exacting requirement was the coating for the interior metal parts of all aircraft engines.

"In replacing chromium plates on machine tools these baked coatings were found to give increased resistance on salt spray testing.

"The navy specified resin baking coatings to prevent surface corrosion in the interior of pressure vessels exposed to salt water, alcohol, gasoline and lubricating oils. The Quartermaster Corps used them on steel hardware items where 'corrosion and abrasion resistance are of prime importance.'

"While supplying these and other requirements drew the attention of many coatings manufacturers to baked phenolic resins for the first time, they really became alert to their values because of the many severe tests required in the procurement specifications. It was these required performance tests and meeting them in the laboratories that astonished many manufacturers with their unusual performance. The alert manufacturer saw in them the answer to many industrial coating problems and the potential business in many fields not usually entered by paint and varnish products."

While the value of phenolic resin baking coatings for the corrosion resistance of steel pipes had long been recognized, the report goes on, a production handicap was presented in the time and oven equipment for baking. A temperature of about 375 F. degrees had to be reached and then maintained for 30 to 45 minutes. However, the development of the continuous induction heating method is believed to have largely overcome these handicaps.

The induction heating process is described as follows in the report:

"Induction heating differs from the conventional radiation or convection heating techniques in that the heat is induced in the metal object by passing the coated object through an electromagnet field actuated by a high or low-frequency alternating current. By this method continuous production cycles for curing the resin baking coating may be obtained, giving uniform cures in a few minutes. For example, coatings which are ordinarily baked at 275 to 400 F. for periods of 20 to 60 minutes (using the usual baking ovens or infra red units) are passed through an induction heating coil and baked in a few moments.

"Moreover, in baking ovens the outside of the coating is heated first, with the possibility of 'case hardening' the film, due to the under side, next to the metal, not receiving sufficient heat. Using induction heating, the film next to the metal is heated first, thus assuring proper and uniform curing.

"The application of high frequency and low frequency alternating currents for heating is growing rapidly in many fields. Such methods have long been used in the metal industry to supply the heat for hardening, heat treating, brazing, soldering, annealing, forging and melting. The application of high frequency to the heating of thermosetting molding materials first announced in 1943, has been adopted rapidly by the plastics molding industry, so that today a substantial tonnage is so processed.

"High frequency heating is also far from a novelty in plywood gluing as well as other adhesive uses. In the manufacture of radio tube bases the metal elements in the tube are heated through the glass at the time the vacuum is produced. To take care of these requirements the alternating current apparatus and equipment is being produced by many manufacturers. The equipment is becoming further refined and made available in ever increasing volume. Its application therefore to the field of protective coatings is increasing in interest."

The continuous induction heating method in laboratory size is described in the report as follows:

The sandblasted pipe is introduced into the resin bath and coated inside and out. It is then mechanically withdrawn, passing through the heating coils. These coils supply the electro-magnet field actuated by low-frequency alternating current. The pipe is brought from room temperature to 400 F. in two minutes by the lower coil, held at this temperature for three minutes by the upper coil and then hoisted out and allowed to cool. The pipe while being heated is passed through the coil but is never in direct contact with it. By increasing the amount of power supplied, the speed of baking is increased. Fig. 1 is a diagram of the laboratory continuous pipe coating equipment.

The portion of the report discussing instances in the petroleum and other industries of the application of coatings to protect steel pipe is summarized below:

Buried Pipe Lines

The studies of the National Bureau of Standards on steel pipes, coated with all sorts of clears, enameled, hot melts and wrapped coatings and buried in various types of corrosive soils for 4 to 6 years, showed that the phenolic resin baking coatings were practically unaffected, even to retaining high gloss after cleaning.

Boiler tubes in low pressure stationary boilers have long been a source of expense and danger because of corrosion, especially when using certain types of water. One installation frequently had tube

The accompanying article is a review of the report, "Resin Baking Coatings by Induction Heating", by Robert J. Moore, Technical Coordinator, Bakelite Corp., presented before the 1945 Fall Regional Meetings of the Federation of Paint and Varnish Production Clubs.

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failure in three months' operation. On the outside of the tubes was water containing mineral salts at 220 F.; on the inside flame and flue gases at approximately 675 F. By replacing with steel tubes protected with two coats of phenolic baking resins, there has been no failure in four years. This protective treatment for boiler tubes and also for condenser tubes is increasing.

Oil Refinery Heat Exchanger Tubes

Another case in point is connected with the petroleum refinery heat-exchanger tubes which need to resist brackish to salt water at 180-212 F. on the inside and gasoline and oil at 215 F. on the outside. Formerly even Admiralty metal tubes failed in four months. Today steel coated with the baking phenolic has been in use nearly two years and is still unaffected.

Solvent Recovery Plants

Solvent recovery systems at powder plants presented their corrosion problems. It was required that the coating on the steel resist fluxing of mixed benzene, steam, alcohol and acetic acid. The resin baking coating met these requirements in tests completed in 1940. In many solvent recovery plants there is need for this protection. In one, the interior of the equipment was badly corroded and pitted after two months operation due to the combined action of steam, solvent and acid vapors. This equipment, cleaned and protected with two coats of resin baking coating, each ⅜ mil. thick, is now in excellent condition after four months' operation.

Pipe Line Coatings

Recent tests on natural gas pipe lines have shown that the inside coated with phenolic baking resin yields a clean, smooth surface which reduces friction losses. Large refinery tests have shown that these coatings withstand the corrosion and pressure conditions in natural gas lines at 720 psi. These tests involved resistance to lubricating oil and to 30% solution of calcium chloride. Further tests indicated freedom from blistering due to occluded gas pockets in the coating after subjection to alternate high and low pressure in the lines.

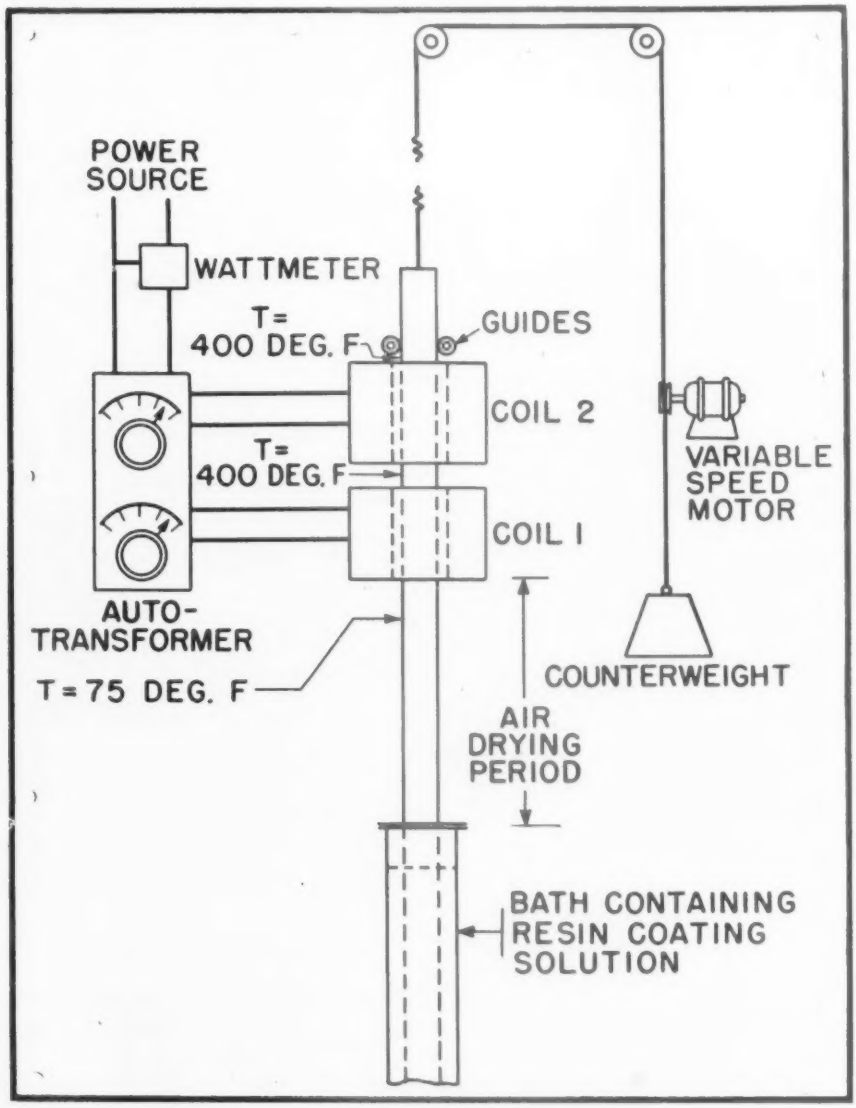

Fig. 1—Diagram of laboratory continuous induction pipe coating equipment.

Properties of the Finishes

The properties of resin baking finishes and their uses prior to the war are described in the report as follows:

"These are plastic coatings prepared from solutions of partially polymerized phenol-aldehyde resins which have been hardened to a glass-like surface by means of heating. It is through this heating or baking period that the phenolic resin is converted from the alcohol soluble stage by polymerization to the insoluble, infusible so-called 'C-stage.'

"This will be recognized as the reaction which underlies the utility of the phenolic heat-reactive, or so-called thermosetting, resins in their extensive applications in molding plastics, laminates, and thermosetting bonds and adhesives. Because of this polymerization conversion the resulting film differs markedly in properties, particularly in hardness and resistance values, from the paint and varnish films based upon drying oils or their fatty acids which depend largely on oxidation for their film formation.

"Oxidation products are less durable and less resistant to chemical action than polymerization products. Moreover oxidation, and its resulting acidity, tend to continue long after the film has hardened, thus leading to further embrittlement and instability. 'Oxidation after film formation tends to become film destruction. This is evidenced by increase in acid number in the film and subsequent loss of weight through the formation of volatile products.'

"Certain resins used with drying oils may decrease substantially the percentage of oxygen intake on drying at room temperature and the subsequent oxygen absorption on aging. For example, dried tung oil films alone show an increase of weight of 12% after nine months. Tung oil containing 30% ester gum increases 15% in weight in the same period, while with 30% run congo an increase of 13½% in weight is noted. By treating the tung oil with 30% para phenyl phenol formaldehyde resin the initial hardening time is reduced and after nine months' aging the weight increase is only 8½%. However, by eliminating oxidation entirely through the use of oil-free thermosetting films, we produce the required durability and the resistance factors.

"These oil-free thermosetting resins are supplied to the paint and varnish manufacturer generally as solutions of the resin in alcohol type solvents, which require further dilution before application. However, the resin is also available in solid, lump form. This is a non-sintering resin, easily pulverized or broken for solution in alcohol-type solvents. Many varieties of these phenolic resin solutions are available, their compositions designed to meet specific coating requirements. They may be pigmented or dyed, as required, by the coatings manufacturer."

Arc Welding Permits Field Repairs On Corroded Pressure Vessel

Technique Worked Out for Replacing Bottom Nozzle in High Temperature Reaction Chamber Includes Installing Stainless Steel Facing with Weld Metal, Together with Method for Preheating and Stress Relieving

By Frank G. Clark

General Foreman, Boilermakers and Welders

Baton Rouge Refinery, Standard Oil Co. of N. J., Louisiana Division

UNTIL recent years, field welding for strength on petroleum refinery pressure vessels was limited. During the past 10 years, however, the art of welding has progressed rapidly and new processes and techniques have been developed which now make it possible to successfully repair almost any type of metal of almost any size or shape by welding. At the same time, these developments have made it possible to do repairs in the field which otherwise might have to be made in some fabricator's welding shop.

In petroleum refining it has been most important that the latest welding procedures and techniques be employed to the fullest extent for the mass volume of maintenance and repair work. So it is that when the need arises for repairing a pressure vessel, pipe line, tubular still, or in fact any other piece of refinery equipment, the situation is surveyed to see what method of welding might be employed. The following discussion has to do with a particular case wherein a high pressure, high temperature reaction chamber was successfully repaired in the field by the electric arc welding process with welding equipment and supplies furnished by the Lincoln Electric Co., Cleveland.

This reaction chamber is a 6-ft. diameter by 40-ft. long vertical drum. It is a forged seamless carbon steel vessel with conical shaped heads, having a manhead opening at both the top and bottom and being void of any internal equipment. It had been in service for approximately 10 years when, as a result of corrosion, it became necessary to renew a nozzle in the bottom conical head. This nozzle is shown in Fig. 1. It had been installed originally by inserting a forged nipple, with a machined shoulder on one end, through a drilled hole in the conical section of the drum so that the shoulder contacted the inside surface of the drum. A retaining ring nut, adjacent to the outside surface as shown in Fig. 1, was then installed and seal welding was provided both on the inside and outside of the drum.

Procedure Outlined

In making the renewal, it was decided that the best method would be to remove the old nozzle, build up a boss with weld metal on the outside surface, and provide this boss with a ring groove and bolt holes for studding a ring joint pipe connection directly to it.

When the old nozzle was burned out, numerous cracks were noted in the metal immediately surrounding the opening in the vessel wall. It was also discovered that previous repairs had been made to the forged metal around this nozzle opening by welding, and all the cracks seemed to lay within the confines of this old weld metal. It was, therefore, decided that before any new weld metal could be applied, all of the old weld metal would have to be removed until perfectly sound forged metal was contacted. This required machining a recess in the outside surface 2-7/8-in. deep and 15-in. in diameter. This recess was then filled with carbon steel and 18-8 chrome nickel steel weld metal and the nozzle opening was equipped with an 18-8 chrome nickel stainless steel liner.

The stainless steel welding was used as the facing for the ring groove of the ring joint connection, and this facing together with the stainless steel liner in the nozzle was provided as a protection against future corrosion and erosion. The stainless steel facing was of sufficient

Fig. 1 — Original nozzle installation showing welded retaining ring unit

Fig. 2—Stainless steel weld metal facing for ring joint connection is indicated in this close-up view

Fig. 3—Finished weld-repaired job after machining, drilling and tapping operations

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depth and diameter to receive a ring groove for a 6-in., 1500-lb. ring joint connection. Fig. 2 shows the line of demarcation between the carbon steel and the alloy weld metal on the outer surface of the welded boss.

In order to assure completely sound and satisfactory welding, it was necessary to preheat before welding and stress relieve afterward. For this purpose, a gas ring burner was installed in the bottom manhead, a damper was installed in the top manhead, and the metal temperature was controlled by the installation of a metal thermocouple in the vicinity of the repair. The metal temperature was raised until it was slightly in excess of 400° F. at which time the welding of the boss was started. As the welding progressed, the metal temperature was raised at a slow rate so that at the completion of all welding, the temperature had risen to 725° F.

Stress Relieved

The stress relieving which immediately followed the welding was carried out by increasing the metal temperature to 1050° F. at a rate of 30° per hour. Ten hours were then required for stress relief soaking time, calculated on the basis of holding this temperature one hour for each inch of metal thickness at the point of repair. After this length of time, the metal temperature was lowered at a rate of 27° F. per hour to 325° F., at which point the gas fired burner was cut out all together.

The welding of this repair job was very tedious for the welding operators because of the position in which the weld metal had to be applied and because of the intense heat to which they were subjected while welding. The external insulation on the vessel had been allowed to remain in place except around the nozzle that was being repaired and this made the heat radiation from the point of repair rather excessive.

121 Welding Manhours Required

As much shielding as possible was used to protect the welders from the heat without impairing their movement to the extent that the quality of their welding would be affected. Even so, it was necessary that welding operators be switched frequently, since it was desired to have all weld metal applied continuously and the entire job required a total of 121 welding manhours.

In making this repair, the welders used 250 pounds of carbon steel and 100 pounds of 18-8 chrome nickel steel welding electrodes. The finish job after machining, and drilling and tapping the holes for the stud bolts, is shown in Fig. 3. There was not the slightest sign of distress or cracking in the finished repair and, since the time that this job was completed, no trouble has been experienced with the new type of connection.

Keeping Up With the News

By N.P.N. Special Writer

Topics discussed below include *cellulose propionate*, a new plastic based upon a chemical from natural gas; *synthetic organic chemicals*, which include, from a statistical viewpoint, plastics and synthetic rubber, revealing a tremendous growth in all divisions during 1944; *automobiles*, announcement of several new light cars; *alcohol*, a substance both used and produced by the petroleum industry; and *atomic sidelights*, a discussion of a recent article on military secrecy.

This series of reviews is prepared to provide linkup of current happenings in scientific and industrial fields with future aspects of the petroleum industry, in order to aid refiners in keeping "up with (and ahead) of the news."

Cellulose Propionate

The recent announcement, by the Celanese Plastics Corp., of the commercial production of a "new" plastic, cellulose propionate, is of interest from several points of view. First of all, it adds another to the list of "plastics from petroleum," for the constituent propionic acid is said to be produced "from natural gas," and, secondly, it places on the market another of a family of "cellulose ester plastics" which have proved of outstanding merit.

Cotton linters or wood pulp provide the "natural" long-chain molecular structure which is chemically modified in these man-made esters. Acetic acid and acetic anhydride (both produced in several ways from petroleum) are the chemical modifiers in the production of cellulose acetate, which is used both as a plastic and as "acetate rayon." Butyric acid (also producible from petroleum) is added for the synthesis of cellulose acetate butyrate.

Cellulose acetate plastics are "noninflammable, highly resistant to impact, transparent or available in a wide range of colors, and adaptable to swift injection molding and extrusion. ° ° ° The acetate-butyrate plastics have greatly superior moisture resistance, improved dimensional stability, excellent weather resistivity, and high impact strength." Available in a great variety of colors and moldable by injection, compression, or extrusion, they found a host of military applications during the recent war. Scintillating acetate-butyrate fibers are also attracting attention.

Propionic acid was used as early as 1937 in the preparation of a similar mixed ester, cellulose acetate-propionate. It is possible that a shortage of this acid and its high cost prevented development comparable to that for the other esters.

Celanese, naturally, has not revealed how it is making its propionic acid from natural gas. The Bishop, Texas, plant of the Celanese Corp. of America (parent of Celanese Plastics) recently put into operation a unit producing various chemicals by the oxidation of "natural gas"[1], and it is possible that propionic acid is one of the products.

More probably, it may be produced from one of the oxidation products. Ethyl alcohol is not one of the products usually so produced, but this chemical, for example, can be made to yield propionic acid by catalytic reaction with carbon monoxide.

Propionic acid may never command a large-volume market, but, even if it does not, its commercial production from petroleum hydrocarbons is of more than academic interest.

Synthetic Organic Chemicals

This interest is further sustained by figures contained in a recent report of the U. S. Tariff Commission[2]. This latest of a long series of annual reports is of particular interest in that the end of wartime secrecy has permitted the release of far more statistics on "chemicals from petroleum" than have ever before been published in a Government bulletin, even in the excellent report for 1943[3].

The latter report stated that some 1,564,914,665 lbs. of "chemical raw materials" (exclusive of toluene) were derived from petroleum in 1943, an increase of 500,000,000 lbs. over 1942. In 1944, however, the current report shows that "production of chemical raw materials derived from petroleum amounted to 3,000,000,000 lbs.," on a comparable basis!

This total was divided as follows: naphthenic acid, 28,462,000 lbs.; xylenes, 354,639,000 lbs.; ethylene 272,188,000 lbs.; propane and propylene, 214,555,000 lbs.; butadiene, 488,945,000 lbs.; 1-butene and 2-butene mixture, 202,380,000 lbs.; "all other" C_4 hydrocarbons, 569,087,000 lbs.; and "all other" chemical raw materials from petroleum, including benzene, other "crudes" from petroleum, and other petroleum hydrocarbons (but not toluene), 841,240,000 lbs. A large fraction of the 29,052,000 gal. of cresylic acids produced from all sources in 1944 was included in the latter figure.

It is interesting to note that 723,814,000 lbs. of butadiene were produced from alcohol in 1944. Butadiene from this source has a unit value of 38 cents per lb., compared with (a since greatly-lessened) 29.7c per lb. for petroleum butadiene. Ethylene from alcohol brought 77c per lb., compared with 4.5c per lb. from petroleum (for vastly larger sales, however).

Chemical raw materials from petroleum brought an average unit price of only 7.2c per lb., another reason for their widespread use. Naphthenic acids cost 8.7c per lb.; xylene, 2c per lb.; propane and propylene, 0.8c per lb.; and 1-butene and 2-butene mixture, 2c per lb. Cresylic acids from all sources averaged 5c per lb.

In regard to toluene, figures given are incomplete (minus those for plants under Ordnance control) but indicative. Production of chemical grades of toluene from petroleum totaled 62,570,000 gal. in 1944, most of this figure (60,155,000 gal.) selling for an average of 32c per gal. In addition, but still not including Ordnance plant production, 33,643,000 gal. of "aviation-grade" toluene were produced in petroleum refineries in 1944. Other toluene production (from coal tars) amounted to 37,772,000 gal., most of which sold for an average of 27c per gal.

Many figures were given for other chemicals which are derived in large part from petroleum raw materials. These include acetic anhydride, 495,522,000 lbs.; acetone, 328,428,000 lbs. from isopropyl alcohol and (only) 56,386,000 lbs by fermentation; amyl acetates, 13,861,000 lbs.; amyl alcohols, 18,527,000 lbs.; butyl alcohols,

(1) Anon., NATIONAL PETROLEUM NEWS, *Technical Section*, 37, No. 36, R-743 1945, "Keeping Up With the News—Petroleum Chemicals."

(2) Anon., *Synthetic Organic Chemicals, United States Production and Sales, 1944 (Preliminary)*, United States Tariff Commission (Washington), September, 1945.

(3) Anon., NATIONAL PETROLEUM NEWS, *Technical Section*, 37, No. 6, R-130 (1945), "Keeping Up With the News—Synthetic Organic Chemicals."

246,444,000 lbs.; carbon tetrachloride, 209,802,000 lbs.; chloroparaffin, 43,560,000 lbs.; ethylene glycol, 202,451,000 lbs.; formaldehyde, 522,440,000 lbs. (37% by weight); isopropyl alcohol, 522,825,000 lbs.; methyl chloride, 24,299,000 lbs.; and many others.

Petroleum sulfonates comprised 29,520,000 lbs. of the 74,264,000 lbs. of cyclic surface-active agents (detergents, wetting agents, etc.) and an unidentifiable fraction of the 77,990,000 lbs. of acyclic surface-active agents also produced.

Many interesting statistics are included on plastics and synthetic elastomers. Production of cyclic resins reached a new peak in 1944, some 404,105,000 lbs. being produced, out of a grand total for all synthetic "plastic materials" of 784,137,000 lbs. (net resin content). The 380,032,000 lbs. accounted for by acyclic resins also constitutes a record and indicates that this class, in which many "petroleum resins" fall, is of ever-growing importance.

Among pertinent statistics are: allyl and furfuryl alcohol polymerization resins, 373,000 lbs.; polyvinyl alcohol, ester, and halide resins, 111,900,000 lbs.; and polyvinyl alcohol-aldehyde resins, 14,992,000 lbs. Some 10,571,000 lbs. of polystyrene resins were produced in 1944, at a new low of 28 cents per lb.

"Protective coatings led all other uses of plastics materials in 1944, production for this use amounting to 293,000,000 lbs. (chiefly alkyd resins). The second largest individual use of plastic materials in 1944 was for molding and casting, which consumed about 120,000,000 lbs." Other uses included adhesives and materials for laminating; textile, paper, and leather treating; glazing; and ion-exchange.

In regard to synthetic rubbers, pertinent statistics agree with others previously presented. It is interesting to note that 33,114,000 lbs. of Buna-N type elastomers were produced in private plants (at 47 cents per lb.) and 4,617,000 lbs. in Government plants. Butyl production totaled 42,315,000 lbs., selling at 26c per lb.

Statistics such as these are vital to the understanding of a growing field, even if certain valuable information must be masked in order to prevent revealing confidential data from specific and easily-identifiable companies.

It is often valuable, however, to scan less-official sources for additional information. In recent weeks, various journal articles have revealed: (1) that the total production capacity of toluene from petroleum (prior to VJ-Day) was 17,000,000 gal. per month of nitration-grade toluene (obviously including Ordnance plants), (2) that the Ethyl-Dow capacity for ethylene dibromide production is now 275,000 lbs. per day, compared with 23,000 in 1935, and (3) Buna-S production for the last five months of 1945 will be 74% from petroleum butadiene, which accounted for 51% of production for the first seven months of this year, 36% in 1944, and 23% in 1943.

These sources also state that Butyl rubber cost only 16.5c per lb. in the first five months of this year and that lower costs are anticipated.

Someone once said that the word "statistics" was the superlative of "lie," but this is true only where figures are misused. Properly reported and understood, statistics give business enterprise something of the quantitative nature of a true science.

Automobiles

A healthy sign of the return to peacetime production is the rash of announcements of plans to produce automobiles[4]. Some of these cars can be taken with a sizeable grain of salt, since a few are based chiefly upon the hope for quick profits in a sellers' market rather than upon sound engineering, but others are actually outgrowths of wartime production advances.

William S. Jack, president of Jack & Heintz, Inc., has revealed that his company plans to produce a new type of gasoline engine—"as a matter of fact, we may be producing our own automobile before the close of 1947." The motor in question, it is said, was ready to go into production for AAF use when the war ended and is a "light, powerful" engine developed in cooperation with the Skinner Motors Corp. of Detroit. Of the pancake type, with horizontally-opposed cylinders, the engine is said to have a precision, die-cast aluminum cylinder section, assembled by welding.

Henry J. Kaiser and Joseph W. Frazier are said to have inspected the Jack & Heintz production facilities and to have begun "to talk about a deal." A two-cylinder engine, which is said to develop 28 horsepower and to weigh less than 50 pounds, is thought to be suitable, perhaps, for the low-price "Kaiser," while a six-cylinder engine might be used in the middle-priced "Frazier."

Two California companies have announced plans to market small, low-priced cars. One of these, the "Californian," would be a three-wheel three-passenger car weighing 1000 pounds and powered with a four-, six-, or eight-cylinder engine; "a four-cylinder installation has given the car 40 miles per gal., a cruising speed of 60 mph., and a top speed of 80. The frame is of tubular steel aircraft construction, and the steel shell of the body can be made of four Kirksite-

(4) Business Week, No. 840, 52; No. 841, 66; No. 843, 60 (1945); *Wall Street Journal* CXVII, No. 98, 5 (1945).

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die stamped sections welded together." The car is said to have a Plexiglas windshield which shows no evidence of dust scratching and a hydraulic brake which operates when the accelerator is eased to off-power position." The car will use 12-in. tires.

The other car, the "Bobbi Kar," may weigh about 500 lbs., get 50 miles per gal. of gasoline, and run up to 60 mph. "An experimental chassis with a 72-in. wheel base is undergoing tests. Two styles of laminated plastic bodies are planned." The car may use a rear-mounted, one-cylinder engine developing approximately 16 horsepower.

The automobile market will be insatiable for the next few years. Unless the public becomes less comfort and power minded, however, it is unlikely that any major portion of demand will call for light, economical cars. Nevertheless, a number of these models may become established sellers, and economists are not discounting their possible influence (as part of a general trend) upon the future consumption of automotive gasoline.

Alcohol

Ethyl alcohol continues to "interest" the petroleum industry in many ways. Millions of gallons are sold each year as antifreezes for automobile engines. Millions of gallons are annually produced from ethylene, a petroleum hydrocarbon. Larger quantities, from miscellaneous sources, have until recently been used for the manufacture of butadiene, in (uneconomic) competition with petroleum materials. Alcohol-water injection in automobile engines is a topic attracting considerable attention at present. Finally, there remains the ever-present idea, sponsored by farm enthusiasts, of using alcohol as an automotive fuel, at least in blends with gasoline.

Most of these topics are far too lengthy and important for discussion here, but a recent survey on alcohol economics[5] is sufficiently concise to merit attention here. To quote the summary of this report:

"Data presented include only the cost of raw materials, processing, and depreciation. Not included are such factors as administrative overhead, selling expenses, freight absorption, cost of denaturation, and profit. On this basis, the following cost estimates may be made:

"(1) With total cost of pure ethylene at 3c per lb., cost of synthetic alcohol would be 13-14c per gal. If ethylene is made available at 2c per lb., cost of synthetic alcohol probably will be 10c per gal. or less.

"(2) with a (blackstrap) molasses cost of 5c per gal. cost of molasses alcohol would be about 16c per gal.

"(3) Assuming corn at 45c per bushel, cost of grain alcohol would be 20.5-23.5c per gal. Price of corn will probably be higher for a number of years.

"(4) For relatively large plants of 300 tons of pulp per day, present cost of alcohol from waste sulfite liquor is estimated at 15-19c per gal. Postwar costs would be lowered by at least 2c per gal.

"(5) Assuming a waste wood cost of $2 per ton dry basis, f.o.b. processing plant, estimated cost of wood hydrolysis alcohol would be 20.5-22c per gal.

"Therefore, provided the raw material price is sufficiently low, molasses alcohol should be able to compete successfully with the synthetic product. If ethylene should approach 2c per lb., molasses alcohol producers would require a raw material price of about 3c per gal. in order to compete.

"Alcohol from waste sulfite liquor should be able to compete with alcohol from five-cent molasses, provided plants are located equally accessible to the markets. Grain and wood waste appear to be relatively high cost sources."

The writer by no means agrees implicity with all of these conclusions, which are admirably supported in the text of the report, but it does appear that they are based upon logical economic premises. Blackstrap molasses may never again sell in quantity in this country for 5c per gal., however.

Petroleum ethylene seems a most economic raw material for the production of ethyl alcohol. It was recently revealed that Standard Oil of New Jersey is producing at least 20,000,000 gal. per year of this substance at its Baton Rouge, Louisiana, refinery and that this alcohol "can sell at 26c per gal. compared to the 78 to 90c paid for grain (wheat) alcohol." It would appear that considerably lower prices could still be profitable, at least for future developments.

Atomic Sidelights

If one could keep an open mind on the pros and cons of the present argument concerning keeping the "secret" of the atomic bomb (really, the details of engineering "know-how"), he would find it more than "entertaining" to witness the political maneuvering on this grave and important subject—certainly the most important technical topic ever to enter into public debate.

Unfortunately, much more is at stake than the decision as to whether or not we will give Russia the engineering details—to call a spade a spade. Most of this nation assumes that the government will arrive, in the end, at some solution which will help to keep world peace and will prevent our cities (and those of the world) from being transformed into rubble. Meanwhile, however, lack of clarity on the technical aspects of atomic energy and the basic concepts of research may cause our government so to enmesh domestic work on atomic energy that, even if atomic bombs are never again used, by anyone, we may find ourselves lagging behind those nations whose science and technology are not hampered by the application of too much secrecy.

In this connection, a recent article in *Fortune*[6] is of considerable significance. Ridenour, nuclear physicist who did not work on the atomic bomb but who did do much important war work on radar (hence his knowledge of military security), uses the following sentence as the subtitle for his article: "If we hide the facts of nature, we can undermine the security of achievement."

According to Ridenour, security by achievement is preferable on almost every count to security by concealment. For operational security, the latter is the logical approach, but "in science it is safer to achieve results than to attempt concealment." Many of our secret weapons were actually hampered or delayed by too much secrecy; so were some of those of our enemies, through the same mistaken approach.

"Weapon security should be considered on the merits of each case," of course, but "in outsmarting the enemy there is a danger of outsmarting oneself." Ridenour's examples are clear and to the point. In one paragraph, for example, he states that:

"Further, it is worth remarking that the best technical weapons do not depend on secrecy or surprise for their effectiveness. The German V-2 rocket was such a weapon. Long before it was used, I sat with a committee that met many times in London to discuss countermeasures for V-2 on the basis of the quite accurate information we had of its properties. The only hopeful one we were able to think up was that of winning the war; and this was successfully applied."

Ridenour concludes with the answer given by most scientists to the "question of the day," even though their efforts to clarify the issue and to insure public understanding meet with such Churchillian rebuffs as a reminder that governments and not scientists will decide the issue:

"In effect, the problem of policing or of organizing the world, if it is raised at all by the development of the atomic bomb, must be actively and not passively solved. This must be done within the next two or three years.

(5) Tousley, R. D., *Chemical and Metallurgical Engineering* 52, No. 10, 123 (1945), "Alcohol Economics Will Determine Future Production Processes."

(6) Ridenour, L. N., *Fortune* 32, No. 5, 170 (1945), "Military Secrecy and the Atomic Bomb."

No. 3 in a Series

Use of Phosphorus Sulfide Organic Reaction Products As 'Lube' Oil Additives

By George G. Pritzker

U. S. Patent Examiner

Lubricating oil additives containing both phosphorous and sulfur as essential constituents are a relatively recent development in this field. They were originated to meet the severe requirements of modern automotive and other type engines operating at higher pressures and temperatures. In addition to imparting extreme pressure properties to lubricating bases and increasing their film strength, they have been found to inhibit corrosion of certain alloy metals used in bearings and other parts. In addition many of these compounds impart good detergent qualities to the lubricant.

In showing the numerous types of compounds of this general nature, the author has divided the patent literature into two classes. The first includes inorganic phosphorus sulfide-organic reaction products, the second organic compounds containing phosphorus and sulfur as essential constituents. Some 114 patent references are listed and described briefly, starting in 1938.

This is the third and concluding article in this series appearing exclusively in the NPN Technical Section. The first, on Sulfonic Derivatives, appeared in the Oct. 3d issue; the second, on Sulfur and Sulfur Chloride Reaction Products, in the Nov. 7th issue.

George G. Pritzker, author of this series of articles now appearing exclusively in the TECHNICAL SECTION of NPN, has been allied with the chemistry of lubricants for over 8 years, his first position in the field being in the grease department of the Freeman Chemical Co. A graduate Chemical engineer, he is now with the U. S. Patent Office.

ALTHOUGH sulfur and sulfur chloride organic reaction products have been known as lubricating oil additives and used in the lubricating art for a number of years, the introduction of phosphorus sulfide organic reaction products or organic compounds containing both the phosphorus and sulfur radicals as lubricating oil additives has been unknown in the lubricating art until the last few year.

It appears from the evidence accumulated, however, that phosphorus sulfide organic reaction products exhibit tremendous possibilities as improving agents for lubricating compositions. Organic compounds in which these two constituents are present have shown the ability to impart extreme pressure properties to various lubricating bases, as well as to increase their load-carrying capacity and film strength. Some specific compounds and reaction products of this type, in addition, inhibit corrosion, especially of various alloy metals, check oxidation, and prevent sludge, carbonization, and lacquer formation on cylinder and piston walls of internal combustion engines and various other types of engines operating under severely high temperature and pressure. In addition, many of these compounds and reaction products possess the property of acting as detergents, helping to keep the various engine parts clean and in good working order.

Unquestionably, the design and structural engineers deserve much credit for the development of our modern engines and machines. However, due credit also must be given to the lubricating engineers for their ingenuity in compounding and developing phosphorus sulfide containing lubricants which successfully lubricate and maintain in good working order the wonderful and tremendously powerful engines and machines developed in the last few years.

Reason for Improvement

Just how or why the introduction of phosphorus and sulfur into organic oil additives improves the lubricating properties of oils is at this time not known or understood. Test results have shown that sulfur present in lubricants in reactive form imparts a sulfide film to the metal surfaces with which it comes in contact, acting as a protective layer on the metal surface capable of withstanding extreme pressures. This evidence suggests the possibility that in organic products containing both the sulfur and the phosphorus radicals, the phosphorus might act as an activating agent for the sulfur or that a complex phosphide-sulfide protective film capable of withstanding tremendous pressures and high temperatures is formed on the metal surfaces with which the oil additive is in contact.

In the present discussion, the patent literature on this subject will be divided into two parts, the first relating to inorganic phosphorus sulfide-organic material reaction products, the second disclosing various organic compounds containing phosphorus and sulfur as essential constituents. The reference, however, makes no mention as to the preparation of the oil additive, or the additive may be prepared by methods other than that which will be discussed in the first section.

One of the earliest patent references to phosphorus sulfide-organic material reaction products as lubricating oil additives is disclosed in the Ralston[1] patent; Ralston treated aliphatic nitrites with P_2S_5 to obtain an oily material which was non-corrosive to metals and imparted extreme pressure properties to the lubricant. The aliphatic nitrites used were of the saturated and unsaturated type, containing nine or more carbon atoms and having the formula RCN.

An oil additive capable of imparting and improving desired lubricating properties to oils was obtained by Salzberg[2] by reacting naphthenyl alcohols with $POCl_3$, P_2O_5, PCl_5, PCl_3, P_2S_5, $PSCl_3$, $P_2S_3Br_4$ and then neutralizing with alkali. The products formed were neutralized naphthenyl esters of the acids of phosphorus, and mixtures of such acids.

Probably the basic patent on the subject matter under discussion is the Chittich[3] patent, which treated mineral oils and fatty oils in general, including marine, animal, or vegetable oils, such as rapeseed or castor oil, with phosphorus or phosphorus compounds at temperatures sufficiently high to cause the phosphorus to react with the oil. The phosphorizing agents used were phosphorus compounds, such as halides, oxyhalides; compounds of the oxygen family, including oxides, sulfides, tellurides, and selenides; metallic phosphides, such as sodium phosphides, and tin phosphides. A specific example in which P_2S_5 is used as the reactive agent was prepared by Chittich by heating lard oil with 10% P_2S_5 at 290-320° F. for 90 min. The sludge formed during the re-

action was removed and 10% of the treated lard oil was blended with lubricating oil. If greases were desired, soaps of Na, Ca, Pb, or Al sufficient to impart the desired consistency were added.

In order to obtain an extreme pressure oil additive, Lipkin[4] reacted halogen or sulfide derivatives of phosphorus, such as PCl_5, $POCl_3$, $PSCl_3$ P_2S_3, P_2S_5, with primary and secondary amino compounds, such as primary and secondary aliphatic, aromatic, hydroaromatic and heterocyclic amines, to form compounds of substituted amides of phosphorus acids.

Anti-Corrosion Lubricants

Benning[5] disclosed that an anti-corrosion lubricant can be obtained by treatment of oils with P_2S_5, $PSCl_3$, $P_2S_3Br_4$, etc., to form organic esters of phosphoric acid (phosphate esters). The reaction product thus formed could be further treated with amines to form salts; also, that oils containing mercaptans may be treated with phosphorus sulfide, phosphorus chloride, and phosphorus oxychloride to obtain oil corrosion inhibitors. Specific oil additives thus formed were p-nitro aniline salt of dilauryl dithiophosphate, pyridine salt of dilauryl dithiophosphate, dilauryl dithiophate, diamylphosphate, tripheryl monothiophosphate, dioleyl dithio o-phosphate, trimyristyl monothio m-phosphate, monocetyl monothio o-phosphate, trilauryl trithio o-phosphate, dicetyl monothio o-phosphate, tetracetyl dithio pyrophosphate, trilauryl tetrathio o-phosphate, tetramyristyl trithio pyrophosphate, tetraeicosyl pentathiophosphate, methyl diphenyl monothiophosphate, ethyl diphenyl monothiophosphate, dimethyl phenyl monothiophosphate, and methyl dicresylmonothiophosphate.

A non-sludging, extreme pressure lubricant was obtained by Cantrell[6] by reacting P_4S_3 with a reaction product obtained by treating phenols with olefins such as butylenes, amylenes, etc.

Salzberg[7] states that lack of a lubricating film between rubbing surfaces results in scoring and scuffing of gears, and that failure to maintain a lubricating film on idle bearings causes about 70-80% of the wear occurring on cylinder walls; also that alloy bearings in the presence of highly refined oils, particularly those obtained by solvent refining, are usually susceptible to corrosion. In order to improve such oils, naphthenyl esters of the acids of phosphorus and mixtures of such esters were added to the oil. The "naphthenyl alcohols" were obtained by the carboxylic reduction of naphthenic acids and their esters. In naphthenyl alcohols, the hydroxy group is in the side chain as distinguished from the cycloaliphatic alcohols, in which the hydroxy group is attached to the cyclic nucleus. The esterifying agents used were $POCl_3$, P_2O_5, PCl_5, PCl_3, P_2S_5 $PSCl_3$, P_4S_6, P_2S_3Br. When P_2S_5 was used, dithio o-phosphate resulted.

Smith[8], in order to obtain an oil improving agent, reacted phenol-olefin condensation products with $POCl_3$ in the presence of P_4S_3 to form phosphate esters. To improve the lubricant further, butyl stearate was added as an oiliness agent.

An extreme pressure lubricating oil additive was obtained by Henderson[9] by sulfurizing first and then phosphorizing or simultaneously sulfurizing and phosphorizing lard, cottonseed, castor, or linseed oils at 425-450° F. for about 2½ hrs. Phosphorization usually has a tendency to polymerize the oils; therefore, oils should be sulfurized first with sulfur or sulfur chloride and then treated with P_4S_3 or PCl_3 or P.

To obtain a soluble cutting oil, Anderson[10] reacted 99.6 parts of sulfurized lard oil with 0.4 parts P_4S_3 to form a phosphorus-sulfide base which is blended with a mineral oil and emulsifying agent. An example of such a soluble cutting oil is:

Emulsifier (75% naphthenic acid soap, 25% Twitchell reagent)	15%
Sulfurized-phosphorized base	10%
Lubricating oil	74%
Diethylene glycol	1%

A sulfurized-phosphorized extreme pressure base which is non-corrosive and does not polymerize under working conditions was obtained by Whittier[11] by treating vegetable, animal, and marine oils, and waxes such as cotton-seed, castor, rapeseed, and sperm oils with P_4S_3, PCl_3, $POCl_3$, P_2S_5, P or stannous phosphide. In the reaction it is essential that both the sulfur and the phosphorus be chemically combined in the product and that no excess phosphorus be present in the end product, because it causes corrosion.

Extreme Pressure Additive

Cantrell[12] obtained an extreme pressure non-corrosive lubricant additive by reacting olein-phenols and $POCl_3$ and P_4S_3. Another oil additive was obtained by Cantrell[13] by reacting P_2S_5 or mixtures of P_2S_5 and PCl_3 with an antioxidant of the olefin-phenol condensation type. Cantrell also secured other oil improving agents by reacting olefin-phenol condensation products with PCl_5[14] or with PCl_3 and S_2Cl_2.

An extreme pressure agent was obtained by Badertscher[15] by reacting PCl_3, PCl_5, $POCl_3$ and $PSCl_3$ with an alkali thiocarbonate.

Morway[16] discloses that oil additives are obtained by heating red phosphorus and sulfur at 340-520° F. The preferred product is P_4S_3 and is secured by heating red phosphorus and sulfur at 625° F. in a current of CO_2, any free phosphorus being removed. To stabilize the P_4S_3 in lubricating oil, waxes such as carnanba, beeswax, montan, or synthetic waxes are used.

Extreme pressure oil additives were obtained by William[17] by treating chlorinated esters or ketones and a phosphorized sulfurized fatty oil and sulfur with P_4S_3.

Lubricating oil improving agents containing both phosphorus and sulfur were obtained by Prutton[18] by reacting P_2S_5 with stearic acid, lauryl alcohol, benzyl alcohol, phenol, butyl stearate, methyl salicylate, naphthenic acid, diphenyl ether, cresylic acid, mineral oil, oxidized mineral oil, fatty oils, such as lard, chlorinated diphenyl ether, mono and dichlorbenzyl alcohol, and para and ortha chlorphenol. Also, $PSCl_3$ was reacted with mineral oil, oxidized mineral oil, naphthenic acid, methyl stearate, lard oil, methyl salicylate, stearic acid, oleic acid, diphenyl, dichlorxylene, dichlorcresol, o-chlor phenol, monochloramyl phenol, methyl dichlor stearate, and chlordiphenyl, to form thiophosphates. Some specific examples are tributyl thiophosphate, triphenyl, tribenzyl, tricresyl tri(chlorethyl), tri(o-chlor phenyl), tri(dichlorxylyl), tri(dichlor cresyl) tri(monochloramyl phenyl), and tri(chlorbenzyl) thiophosphates.

Additives to Combat Severe Conditions

Rutherford[19] disclosed that petroleum oils deteriorate or partially decompose and oxidize when subjected to high temperatures, and form adhesive deposits on hot metal surfaces. In order to lubricate the parts of Diesel type engines operating under severe conditions, in which temperatures in the piston ring zone are about 425-650° F., with pressures from the oxidation combustion gases of 750-1150 psi, Rutherford added alkaline earth metal salts of sulfur containing substituted acid of phosphorus, which are stable to heat and resist oxidation, prevent ring sticking, and inhibit corrosion. The acid can be prepared by mixing a higher alcohol with P_2S_5, or mercaptans with P_2S_5, neutralizing with Ca, Sr, or Ba salts. Examples of compounds used are Ca cetyl phenyl thiophosphate, prepared by reacting cetyl alcohol with P_2S_5, or Ca thiocresyl thiophosphate, prepared with thiocresol and P_2S_5.

An extreme pressure lubricating oil additive was prepared by Whittier[20] by adding chlorinated open chain aliphatic hydrocarbons to a phosphorus or sulfurized and phosphorized fatty oil.

Non-corrosive, oxidation inhibiting and high film strength oil additives were secured by Lincoln[21] by treating with phosphorus sulfides corn oil acid, soy oil acids, oleic acid, and linoleic acid. The reaction products were treated with suitable salts.

Lubricating oil additives were obtained by Asseff[22] by reacting cycloaliphatic alcohols with P_2S_5 to form thiophosphate esters which are, in turn, treated with a zinc salt. Further to improve lubricants containing Zn salts of P_2S_5-cycloaliphatic alcohols, metal phenates, naphthenates, phosphites, and sulfonates can be added.

Whittier[23] discovered that the extreme pressure properties of lubricants containing sulfurized-phosphorized bases are improved by adding dichlor dibenzyl or hexachlor symmetrical diphenyl butane. Chlorinated (octachlor) ditolyl butane[24] also was added by Whittier to sulfurized-phosphorized bases, or pentachlor symmetrical diphenyl pentane[25]. Whittier[26] also obtained an extreme pressure oil additive by treating lard oil with P_4S_3 and S_2Cl_2.

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Hughes[27] developed an extreme pressure oil additive by adding to a lubricant compounds containing furan nucleus, such as furfurin hydrofuramide, trifurfurylamine, and P_4S_3.

Williams[28] and Yule[29] disclose methods of obtaining extreme pressure agents by sulfurizing-phosphorizing fatty materials. In producing his oil additive, Williams desired to introduce sulfur and phosphorus simultaneously into the material.

Downing[30] obtained extreme pressure lubricating oil additives by treating oils containing ethylene linkages or hydroxy groups with phosphorus sulfide.

To obtain lubricating oil improving agents, Zimmer[31] reacted halogenated aliphatic, aromatic, or terpene compounds, such as chlorinated fatty acids, esters, alcohols, or ethers, with P_4S_3, P_2S_5, P_2S_3, or $PSCl_3$, and then neutralized the reaction product.

Phosphorus Improves Sulfur Compounds

Roehner[32] discovered that phosphorus has a tendency to activate and improve sulfur compounds, and used it to improve the extreme pressure properties of sulfur-containing organic compounds. Such an oil additive was obtained by sulfurizing Vinifera palm oil, which is high in unsaturated and saturated acids and responds well to treatment with P_4S_3.

Zimmer[33] obtained an oil improving agent by condensing mercaptides with chlorinated hydrocarbons with or without simultaneously adding P_4S_3, P_2S_5, $PSCl_3$, or S.

Loane[34], in order to inhibit oxidation and corrosion of lubricating compositions, added to such compositions 0.001-10% of reaction product obtained by reacting P_2S_3, P_2S_5, P_4S_7, P_4S_3, etc., with polymers of olefinic hydrocarbons such as isobutylene or isoamylene, or co-polymers of iso-mono-olefines and normal mono olefines containing less than six carbon atoms. To improve such oil additives further, Loane[35] neutralized them with alkali or alkaline earth metals, Al, Sn, Pb, Va, Cr, Fe, Co, etc. He secured a still greater improvement of such oil additives by combining neutralized phosphorus-sulfide olefin polymers with non-neutralized products[36]. The neutralizing agents were alkali and alkaline earth metals, ammonia, amines, Sn, Ti, Al, Cr, Co, Fe. The reaction of P_2S_3, P_4S_3, P_4S_{10}, and P_2S_5 with aromatic hydrocarbons such as benzene, naphthalene, anthracene, toluene, xylene, diphenyl, and the like, or aromatic fractions of petroleum oils obtained in the catalytic reforming of petroleum oils was also observed by Loane[37] to possess lubricating oil improving properties. These reaction products were also neutralized with both alkali and alkaline metals, ammonia, amines, Sn, Ti, Al, Cr, Co, and Fe. Loane[38] also observed that hydrocarbon products having a molecular weight of about 150-300 and derived from paraffins, olefins, olefin polymers, aromatics, alkyl aromatics, cyclic aliphatic, lubricating oil fractions, petrolatum, waxes, cracked cycle stocks, condensation products of petroleum fractions, solvent extracts, when reacted with phosphorus sulfides and then neutralized, markedly improve the lubricating properties of oil.

In order to improve the VI characteristics of an oil, prevent the ringsticking tendency of lubricating oil, and inhibit corrosion, Kelso[39] used neutralized reaction products of P_2S_3, P_3S_4, P_4S_7, P_4S_{10}, and P_2S_5 with organic compounds, such as rubber, natural or synthetic, olefin polymers, synthetic rubber of the butadiene, isoprene, chlorpenepolymer or copolymer type, and polymers having the formula $R = (C\text{-}R_1) - COOR_2$, wherein R is an alkylene radical, R_1 is hydrogen, alkyl, aryl radicals, and R_2 is a monovalent hydrocarbon radical, amine substituted aliphatic radical derived from an amino alcohol, or a long chain fatty acid salt. Also used were volatilized fatty oils or mineral oil, polyesters having vinyl or substituted vinyl groups, polyesters of acrylic acid or of its α-alkyl or α-aryl substituted products, and monohydric alcohols of more than four carbon atoms.

An improved pour point lubricant, and one which is resistant to oxidation and sludging, was obtained by MacLaren[40] by reacting with P_2S_3, P_4S_{10}, P_4S_3, and P_2S_5 condensation products of halogenated aliphatic hydrocarbons with aromatic compounds such as naphthalene, fluorene, phenathrene, anthracene, and coal tar residue in the presence of a catalyst, and neutralizing the entire reaction product.

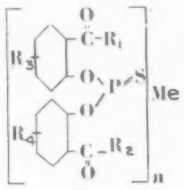
Gaynor[41] states that in order to improve phosphorus sulfide hydrocarbon or olefin polymer reaction products, sulfur or sulfur chloride should be introduced prior to or simultaneously with the phosphorus sulfide. Another oil improving additive was prepared by Loane[42] by neutralizing phosphorus sulfide-hydrocarbon reactions. The reaction of P_2S_5, P_2S_3, P_4S_3, P_4S_7, and P_4S_{10} with high molecular weight copolymers of a low molecular weight mono-olefin, such as isobutylene, 2-methyl-butene-1, 2-ethyl butene-1, hexylene, and an unsaturated olefine, preferably a conjugated diolefin of the butadiene, isoprene, cyclopentadiene-1, 3, is utilized by Anderson[43] as an oil improving additive.

Free Sulfur Prevents Corrosion

Kelso[44] discloses that phosphorus sulfide olefin reaction products can be made non-corrosive by adding in combination with the latter, elemental sulfur or organic sulfur compounds capable of being decomposed to give free sulfur at temperatures at which the lubricants are used. The olefins used in the reaction contained at least 20 carbon atoms and were obtained by the dehydrogenation of paraffins such as cracking of paraffin waxes. White[45] reacted phosphorus sulfide-high molecular weight hydrocarbon oil, known as "resin" or "resinous oil" of 1000-2000 molecular weight or higher. The product was obtained from paraffinic oil which had been dewaxed and treated with liquified normally gaseous hydrocarbons (propane) at 150-180° F to produce two fractions which contained resin-like oils. The heavy fractions were treated with additional propane to form wax-free, asphalt-free, resin-like oil. The reaction product could be used as is or neutralized as a lubricating oil improving agent.

Whittier[46] added halogenated aliphatics, such as hexachlorethane, to phosphorized-sulfurized lubricating bases, while to improve their lubricating properties Williams[47] added to phosphorized-sulfurized bases chlorinated esters and ketones having the formula $RC_n\text{-}COO\text{-}C_n\text{-}R^1$ and $RC^1{}_n\text{-}CO\text{-}C_n\text{-}R^1$, wherein R is an aromatic group. An example of such a compound is dichlorphenyl ethyl cinnamate.

Cook discloses[48] an improved lubricant is obtained, having heat stability, extreme pressure, and good pour point properties, by reacting 4 moles of an acylated phenol with one mole of P_2S_5 to form di (acylphenyl) dithiophosphates having the general formula



where:

Me = alkaline earth metal.

R_1 and R_2 = alkyl, cycloalkyl, or aryl radicals.

R_3 and R_4 = alkyl, cycloalkyl, aryl, or hydrogen.

Other metals which could be used are Ni, Al, Pb, Hg, Cd, Sn, Zn, Mg, Na, K, Ca, Sr, and Br. According to Cook, the

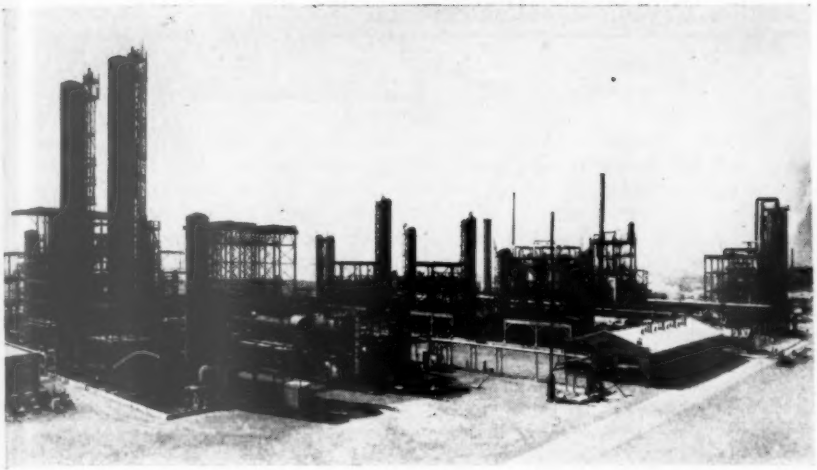
$$-(C=O)-$$

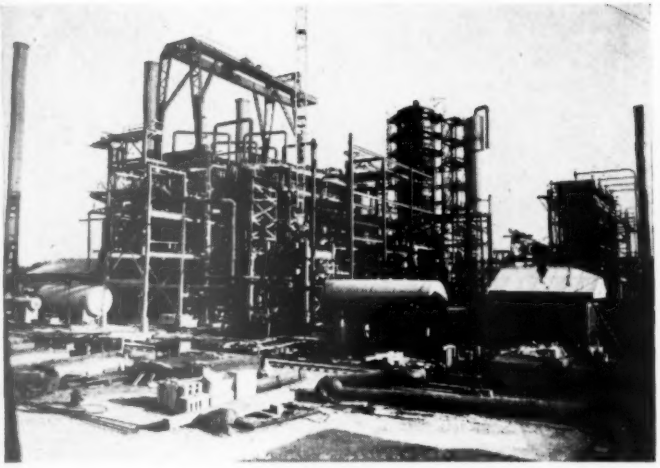
constituent has sludge dissolving, detergent, and oiliness properties.

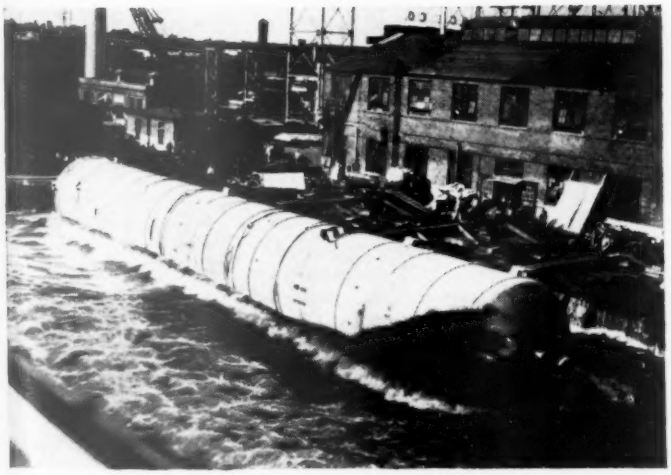
Musselman[49] states that an extreme pressure oil additive is obtained by reacting degras, beeswax, lanolin, carnanba, Japan wax, and sperm oil with P_2S_5 at 300° F and converting the product to a salt by reacting with Zn, Al, Ca, Be, Na, K, Mg, and Sn.

To prevent sludge formation and to inhibit corrosion of lubricating compositions, Burwell[50] reacted oxygenated hydrocarbon mixtures produced by the process disclosed in U. S. Patents 1863004, 2110078, and 2128523, with P_4S_7 at 250-300° F. The products formed are believed to be "thio-alkyls," which embrace thio-ethers, esters, ketones, and polymers thereof.

An oil improving agent was obtained by Smith[51] by reacting P_2S_5 at 250-450° F with alkylated phenols to form complex acid reaction products which were then neutralized. In the reaction, P_4S_3 was used as a catalyst. Oil improving agents were also obtained by Smith[52] by reacting sperm oil alcohols or their equivalents with P_2S_5 at 300-460° F and







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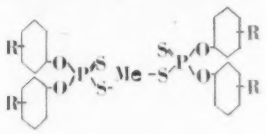
then neutralizing the reaction product.

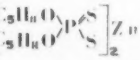
Another oil improving additive was obtained by Smith[52] by treating olefine-phenol reactions with $POCl_3$ and P_4S_5 and then neutralizing the entire reaction product.

Lubricating oil additives for truck, bus, aeroplane, marine, and diesel engines were prepared by Cook[53] by reacting p-tert. amyl phenol with P_2S_5 at 145-155° C to form the p-tert amyl phenol diester of dithio-phosphoric acid, which was then neutralized with the following salts: Mg, Ca, Sr, Ba, Zn, Al, Cr, Sn, Co, Li, and Na. The compounds formed have the following general formula:



In order to improve the lubricant further, 2.4 diamyl phenol monosulfide and oil-soluble salts of sulfonated organic compounds are added, these compounds acting chiefly as solubilizing agents. Another type of ester of dithiophosphoric acid was prepared by Cook[54] by reacting 4 moles of capryl alcohol with one mole of P_2S_5 and neutralizing the product with Li, Na, K, or heavy metals. Neutralized dicapryl esters of dithiophosphoric acid markedly improve the lubricating quality of oils.

Alkaline earth petroleum sulfonates are admixed with the above salts, if desired. Cook[55] also discloses that "Pentasol" reacted with P_2S_5 and neutralized with zinc salts to form zinc salts of diamyl dithiophosphoric acid having the following general formula, improves lubricating oils:



Ba salts of di(dihydro-abietyl) dithiophosphate obtained by reacting dihydroabietyl alcohol with P_2S_5 and neutralizing with BaO are utilized by Cook[56-57] to improve the lubricating qualities of oils. Diaryloxyl alkyl dithiophosphates and their salts, obtained by reacting 4 moles of alkyl substituted phenoxyalkylol with one mole P_2S_5 at 90-110° C, and then reacted with a salt, improves the lubricating qualities of oils.

Oil-soluble salts of sulfonated organic compounds and 2.4 diamyl phenol monosulfide can also be added to the oil in combination with the above salt.

Denison[58] utilizes thioacids of phosphorus alcohol by reacting P_2S_5 and a higher alcohol as stabilizers, and dialkyl thioethers or dialkyl seleno ethers in lubricating compositions.

Burk [59] discloses that the addition of inorganic P_4S_3 to oil improving agents such as diamino diphenyl methane derivates improves the entire lubricating composition.

Cook[60] uses hydrogenated abietyl alcohol esters of dithiophosphoric acids and salts thereof, prepared by reacting 4 moles of hydrogenated abietyl alcohol with one mole of P_2S_5 at 90-110° C, as oil improving agents.

Whittier[61] sulfurizes an acid amide until it is non-corrosive and then phosphorizes it to obtain an oil improving agent.

Oil improving agents are obtained by Faust[62] and Cook[63] by reacting mahogany sulfonates with P_2S_5 under certain controlled conditions.

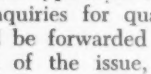
In order to obtain oil improving agents, Prutton[64] reacted P_2S_5 with the following organic materials: stearic acid, lauryl alcohol, benzyl alcohol, phenol, butyl stearate, methyl salicylate, naphthenic acid, diphenyl oxide, cresol, mineral oil, oxidized mineral oil, chlorinated diphenyl ether, chlorinated benzyl alcohol, and chlorinated phenol.

The reaction of an aliphatic alcohol and P_2S_5-terpene to form an oil improving additive is disclosed in the May patent[65].

The reaction of waxes such as wool grease, degras, lanolin, beeswax, sperm oil, etc., with P_2S_5 or P_4S_3 at 275-300° F to improve the lubricating qualities of oils is shown by Musselman[66].

To obtain lubricating oil additives, Cook[67] reacted alcohols, or phenols, monocraboxylic acid, and P_2S_5, which formed complex dithiophosphoric acid esters having the following general formula:

The neutralized form of the above reaction has the following general formula:



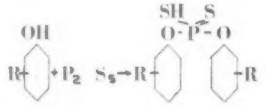
wherein M is a metal.

Mono and dialkyl phenol, mono and polysulfides, and their heavy metal salts were added as detergent agents to the above composition. The reaction of mixtures of branched chain alcohols and P_2S_5 to form dithiophosphoric acid esters was also utilized by Cook[68] as an oil improving agent. Dialkylphenol sulfide was added to this composition to make it more potent.

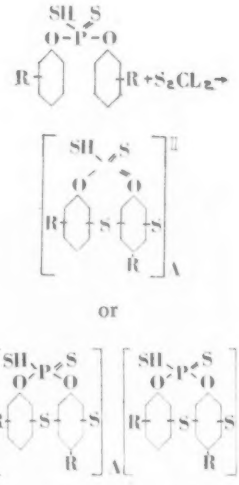
According to Musselman[69], naphthenic acids reacted with P_2S_5 and further treated with a base such as amine, ammonia, metal oxides, or hydroxides, produced lubricating oil improving additives. The reaction was carried out at temperatures ranging from 100-200° C.

Gaynor[70] treated alkylated phenol with phosphorus sulfide, such as P_2S_5, P_4S_7, P_2S_3, and then reacted the product further with S_2Cl_2 or SCl_2. The reaction proceeded as follows:

(1)



(2)



wherein A and B equal 1 to 5.

The final product was neutralized and used as a lubricating oil additive.

Freuler[71] disclosed that octyl alcohol reacted with P_2S_5 and neutralized with Zn or Pb salts formed lubricating oil additives. P_2O_5 could be used instead of P_2S_5 to form oxy-phosphates.

The reaction of phosphorus sulfide on a wax or ester of higher monohydric alcohol and fatty acid in conjunction with a salt of an oxy-sulfur acid is utilized by Musselman[72] as an additive for a lubricating composition.

Neutralized hydrocarbon - chlorsulfonic acid reacted with S_2Cl_2, SCl_2, P_2S_5, P_2S_3, P_4S_3, P_4S_7, PCl_3, PCl_5, P_2O_5, etc., is used by Mixon[73] as a lubricating oil additive.

Non-foaming crankcase lubricants for internal combustion engines were obtained by Cook[74] by reacting P_2S_5 at 90-100° C with branched chain alcohol mixture or mixtures of alcohols and ketones. The reaction product was neutralized with heavy metal salts to form heavy metal salts of dithiophosphoric acid esters in which at least one ester-forming radical is a higher branched-chain alkyl radical containing at least six carbon atoms. Specific compounds thus formed are Ba di(ethyl hexyl) dithiophosphate

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and Ba di-tetradecyl dithiophosphate.

To obtain an additive agent for lubricants, Berger[75] reacted P_2S_6 (PS_2), P_4S_6 (P_2S_3), P_4S_9, P_2S_5, P_4S_7, P_4S_{10}, etc., and a hydrocarbon fraction, known in the art as a thermal recycle stock. Preferred are the liquid and vapor phase recycle stocks obtained in the thermal cracking of petroleum for the obtaining of gasoline. The preferred reaction temperature is between 125-200° C. In order to inhibit haze, phenols substituted with one or more long-chain alkyl groups and alcohols having long chain alkyl groups, such as oleyl, sterol, and waxphenols, are added to the lubricating composition.

Complex dithiophosphoric acid esters prepared by reacting monohydric alcohol and monocraboxylic acid with P_2S_5 at 90-120° C and then neutralized were used by Cook[76] as oil improving agents. The general formula for such reactions is:

Williams[77] prepared an extreme pressure and non-corrosive lubricating oil additive by reacting phosphorus sulfide and one or more metal compounds with fatty bodies to form phosphorus and sulfur bearing metal soaps. The phosphorizing-sulfurizing agents used were P_4S_3 or P_2S_5, and the fatty bodies were wool grease and sperm oil, the reaction temperature range being usually between 150-400° F.

An improved oil additive was obtained by Mixon[78] by treating a reaction product of a phosphorus sulfide and a hydrocarbon with a basic metallic sulfide. As an example, isobutylene polymer was treated with P_2S_5 at 400° F and further treated with Na_2S.

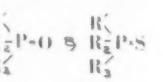
Phosphorus sulfide and dicyclic terpene reaction products were utilized by Noland[79] as oil additives. A specific example is the reaction of P_2S_5 with pinene at 160° C. Sulfonates were added as a secondary oil additive.

° ° ° °

In the above discussion of phosphorus sulfide organic reaction products as lubricating oil additives, reference has been made only to reaction products of inorganic phosphorus sulfide with various organic materials. In order to make this article more nearly complete, the following references are cited because they deal with related subject matter; namely, phosphorus sulfur containing organic compounds used as lubricating oil improving agents. The method employed in preparing such compounds is not disclosed, or differs from that previously discussed.

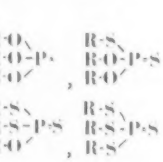
One of the earliest patents on lubricants utilizing thiophosphates to impart non-inflammability to the product is that of Custer[80], who obtained an insoluble water lubricant by dissolving a cellulose ester in a solvent such as dibutyl phthalate. This product was stable, inert with respect to atmospheric conditions, and its viscosity did not change with temperature. When cellulose acetates were used alone or with cellulose nitrates, triphenyl and tricresyl phosphates were used in conjunction with these products because of their marked solvent properties on the acetates.

Butz[81] discloses that the addition of phosphine oxides and phosphine sulfides of the aliphatic, aromatic, hydroaromatic, and heterocyclic type, such as



to lubricants, improves their extreme pressure properties, and such lubricants also are suitable for hypoid gears, free wheeling transmissions, speed reducers, etc. As is well known to those skilled in the art, oils at high pressure and temperatures cannot maintain a lubricating film between metal surfaces. The addition of fatty oils, metallic soaps, sulfur, or chlorine-containing compounds improves oils, due to the adsorption and reaction or union of certain components of these oils with the metal surface, whereby a film of metallic sulfide or chloride is formed. Phosphine oxides and phosphine sulfides appear to be even more potent oil additives than the conventional ones mentioned.

Humphreys[82] discloses that extreme pressure lubricants containing metallic soaps or sulfurized fatty acids or oils cause gumming or tend to separate into their component parts, and that sulfurized fatty oils in which sulfur is in uncombined form cause corrosion and wear. Esters of thiophosphoric acids with hydrocarbon or fatty lubricating oil were used to produce an extreme pressure oil additive for hypoid gears, bearing surfaces, cutting tools, that does not suffer a loss or deterioration of high film strength, has a low rate of wear or low coefficient of friction, and which has no tendency to cause gumming or fouling of the lubricated metal parts. The general formula for such oil additives is:

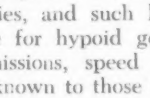


Specific examples of such oil additives are triphenyl-thiophosphate and triamyl-thiophosphate.

Van Peski[83] discloses that alkenyl succinic acid enhances the extreme pressure properties of phosphorus alkyl and aryl esters which may contain substituted groups such as SH and = S.

A large variety of organic phosphates used as lubricating oil additives is disclosed by Benning[84]; among them are: dilauryl dithiophosphate, diamyl phosphate, triphenyl monothiophosphate, dioleyl dithiophosphate, trimvristyl monothio m-phosphate, monocetyl monothio o-phosphate, trilauryl trithio o-phosphate, dicetyl monothio o-phosphate, tetracetyl dithiopyrophosphate, trilauryl tetrathio o-phosphate, tetracetyl myristyl trithio pyrophosphate, methyl diphenyl monothiophosphate, ethyl diphenyl monothiophosphate, dimethyl phenyl monothiophosphate, methyl dicresyl monothiophosphate, etc.

To prevent corrosion of hard metal alloy bearings, Sullivan[85] added to mineral oils organic phosphorus compounds derived from phosphinic and phosphinous acids, having the general formula:



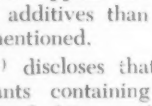
wherein R = hydrocarbon radical

X = O, Se, S

Z = O, S, Se or can be absent

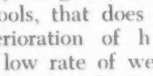
Specific compounds used are: diethyl phenyl thiophosphinite, diiosbutyl phenyl phosphonite, isoamyl dibutyl thiophosphinite, and phenyl diphenyl thiophosphonite.

Lubricating oil improving agents having the formula:



wherein R is an aryl radical, were used by Evers[86].

To prevent corrosion of hard metal alloy bearings in contact with oil, Shoemaker[87] used aryl and alkyl derivates of thiophosphites having the general formula



where X′ is S and X″ and X‴ is O or S.

Specific examples of such oil additives are: mono or di or tri propyl, butyl, amyl, hexyl, phenyl, cresyl mono, di, or tri thiophosphite, dibutyl phenyl mono, di, or tri thiophosphite, and amyl dicresyl mono, di, or tri thiophosphite.

According to Powers[88], the use of thio esters of phosphorus acids such as tricresyl dithiophosphate, tricresyl trithiophosphate and tributyl trithiophosphate, prepared by reacting thio alcohols and thiophenols with PCl_3 or $POCl_3$, in combination with oiliness agents such as high molecular weight fatty acids, fatty acid esters, alcohols, ketones, oxidized paraffin waxes, sulfurized mineral oil, or chlorinated fatty acids, produce good lubricating oil additives.

Prutton[89] discloses that the value of

sulfur compounds which increase the film strength of lubricants is enormously enhanced by the presence of halogen-containing or of halogen and oxygen containing organic compounds. A preferred sulfur additive used was tri-o-cresyl-thiophosphate.

Downing[90] discloses that lubricants for steam cylinders employing superheated steam are improved by adding tricresyl monothiophosphate and phosphite, triphenyl monothiophosphate and phosphite, trinaphtyl monothiophosphate and phosphite, or trinitrophenyl monothiophosphate and phosphite.

Oil improving agents were obtained by Cook[91] by reacting phenol sulfides with PCl_3 to form phosphite esters of phenol sulfides. A specific compound used was di-p-tert . amyl-phenol monosulfide.

Lubricants for internal combustion engines, diesel, and aviation engines were obtained by Flaxman[92] by using oil-soluble metal soaps of pine acids, rosin acids, or abietic acids which can also be chlorinated or treated with sulfur or sulfur chloride to impart oiliness and extreme pressure characteristics to the lubricants. Organic thiophosphates are also added in this composition. Chlorinated esters and ketones such as dichlorphenyl ethyl cinnamate, tetrachlorcinnamyl cinnamate, dichlor cinnamyl aceto-phenone, as well as organic thiophosphates, were used by Williams[93] as oil additives.

Extreme pressure lubricants containing 0.5-45% rosin material, 1 or 2 to 40% sulfur in solution in the lubricant were used by Potter[94], and minor amounts of zinc octyl thiophosphate were added to act as a corrosion inhibitor.

Engelke Sulfurized Phosphines

Engelke[95] obtained a number of patents on oil improving agents by sulfurizing a phosphine at elevated temperatures so that the sulfur attached itself directly to the phosphorus; or by reacting phosphines with PCl_3 and then with sulfur to obtain halogenated phosphine sulfides which acted as corrosion inhibitors.

An oil improving agent was obtained by Morway[96] by reacting mineral oil with sulfur and then treating with PCl_3.

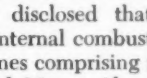
In order to prevent corrosion and sludge formation as well as impart extreme pressure properties to lubricants and to form protective lubricating films on surfaces which are not washed from the sulfur by water, oil, or organic solvents, such as gasoline and naphtha, Downing[97] used aromatic and aliphatic esters of thiophosphorus acids obtained by reacting PCl_3 with mercaptans, thiophenols, and their mixtures. Examples of some compounds of this class are: Trilauryl monothiophosphite, triphenylmonothiophosphite, tristearyl trithiophosphite, lauryl diphenyl trithiophosphite, tridecyl dithiophosphite, and dilauryl cresyl monothiophosphite.

A non-corrosive lubricant for internal combustion engines was prepared by Bergstrom[98] by adding to a lubricant salts of petroleum sulfonates and an extreme pressure agent such as phosphorized sulfurized fatty oils or acids.

Downing[99] utilized aromatic and aliphatic esters of phosphoric and phosphorous acids, such as dilauryl dithiophosphate, as lubricating oil additives.

McNab[100] disclosed that crankcase lubricants for internal combustion engines and diesel engines comprising mixed soaps such as Ca and Mg or Al and Ni soaps are greatly improved by adding minor amounts of Ca di-octyl dithiophosphates.

The use of thiophosphite esters having the general formula



wherein X and Y are oxygen or sulfur and R is a hydrocarbon radical, to form high temperature lubricants is disclosed by Nelson[101].

A flushing oil composition comprising:

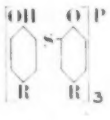
Commercial xylol	10% by volume
No. 2 Fuel Oil	88.9%
Octyl alcohol	0.1%
Sulfurized cresyl phosphite	0.5%
Sulfurized cresyl phosphate	0.5%

is disclosed in the Morgan patent[102].

To prevent sulfur containing compounds from corroding copper, Nelson[103] reacted such materials with an ester of phosphorus acid. For example, di-tert.-amyl phenol disulfide was reacted with tri-cresyl phosphite at 175-180° C to form the inhibitor.

Oxidation inhibitors for lubricating oils utilizing trihexyl thiophosphite, triamyl thiophosphite, tributyl thiophosphite, triphenyl thiophosphite, tritolylthiophosphite, trinaphthyl thiophosphite, and triamyl selenothiophosphite are discussed in the Mikeska patent[104].

Winning[105] discloses that half esters obtained by reacting PCl_3 with a bishydroxyarylsulfide to form compounds having the formula

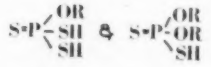


wherein R is an alkyl group, possess the quality of improving the lubricating properties of oil.

High film strength and oiliness agents for lubricants were obtained by Lincoln[106] by reacting an amine with ($PSCl_3$) thiophosphoryl chloride to form such compounds as sulfophosphazomethyl benzoate chloride, $CH_3OCO \cdot C_6H_4 \cdot N : PSCl$, sulfophosphazo benzene chloride, $C_6H_5N : PSCl$, sulfo phosphazochloronaphthalene chloride, $ClC_{10}H_6N : PSCl$.

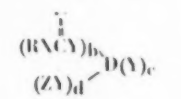
Osborne[107] found that reaction products of dialkyl and diaryl dithiophosphoric acids or their alkali or ammonia salts with chlorine compounds such as S_2Cl_2 or oxidized with air so as to remove hydrogen chemically make excellent extreme pressure oil additives.

Partially esterified thioacids of pentavalent phosphorus having the formula



and, more specifically, salts of Mg, Al, Ca, Ba, Sn, Cr, of monododecyl, monotetradecyl, monocetyl, mono-(decylpheny), mono (cetyl phenyl) esters of tetrathiophosphoric acid, according to Denison[108], have the property of improving lubricating qualities of oils.

Compounds having the general formula



wherein X is oxygen, S, N, and Y and oxygen or S, and D is phosphorus, As, Bi, or antimony, such as diamyl phenyl thiocarboethoxy monothiophosphite, trithiocarboethoxytrithiophosphate and trithiocarboethoxy trithiophosphite, according to Nelson[109], also improve the lubricating properties of oils.

To obtain lubricating oil improving agents, Loane[110] sulfurized phosphatides at 200-300° F.

Cook[111] used the combination of dithiophosphates and organic sulfonates to improve the lubricating properties of oils. The dithiophosphates used were dibutyl, dihexyl, di-n-octyl, dicapryl, dilauryl, di octadecyl dithiophosphates, as well as diphenyl, (di-(2,4 dianyl phenyl) dikeryl diphenyl (obtained by reacting chlorinated kerosene with a phenol in the presence of $AlCl_3$, and further treating with P_2S_5) dithiophosphates and their salts, such as Ba and Ca.

Phosphatides were used by Schreiber[112] to prevent haze formation in lubricants containing metal salts of acid esters of thioacids of phosphorus. The specific salts were Ba salt of dilauryl acid ester of thiophosphoric acid, Ba salt of lauryl acid ester of thiophosphoric acid, Ca salt of lauryl hexyl ester of thiophosphoric acid, Zn salt of lauryl hexyl ester of thiophosphoric acid, Zn salt of dicyclohexyl ester of thiophosphoric acid, and Zn salt of lauryl cyclo ester of thiophosphoric acid.

As extreme pressure oil additives, Engelke[113] used di-phosphorus esters obtained by reacting organic phosphorus acid chlorides with metallic sodium at 150-225° F. Such compounds had the general formula:

$(RX)_2P\text{-}P(XR)_2$
$(RX)^2P=P(XR)$
$(RX)_2XP\text{-}PX(XR)_2$
$(RX)XP=PX(XR)$

wherein X is oxygen or sulfur.

Dietrich[114] used as lubricating oil additives phosphite esters of sulfurized high molecular weight unsaturated alcohols obtained by treating alcohols with sulfur

at 150° C, cooling, and then reacting the mixture with PCl_3.

It must be borne in mind that regardless of what the lubricating oil additives are or how effective they may be as improving agents in engine and machine oils, they cannot be expected to alleviate all the deteriorating factors or mechanical defects which appear during the operation of such machines.

Thus during the operation of engines microscopic metal particles on movable metal parts may cause welding of parts with which they come in contact or may enter the oil system and cause plugging. Moreover, inefficient or poorly designed piston rings and cylinders, or improper protection of engine parts from dust and dirt are major factors which interfere with effective lubrication and efficient running of the engine. Contaminants may also be present in the lubricating oil systems before, during, or after the addition of specific compounded oils, which in time interfere with or cause the deterioration of the most effective or specially compounding lubricating composition.

In addition, the high temperatures and pressures encountered in various engines, in time cause not only the deterioration of the oil itself but also of the additive used to prevent such deterioration.

Additives Form Side Reactions

Side reactions which are formed by the addition of additives to lubricating oils, as well as reactions which are caused by new physical and chemical conditions encountered during operation of engines and machines or even during the idle period, with time change entirely the original characteristics of the lubricants.

These points are mentioned for the benefit of all interested in the field of lubrication in order to clarify and help to understand better the difficult and complex problems faced by the lubricating engineer. Even the most highly skilled lubricating engineer cannot be expected more or less to write a prescription of a lubricant suitable for a specific lubricating problem which would alleviate all the ills encountered. No branch of science has as yet reached this stage of development.

The phosphorus sulfide-organic reaction products discussed above, as well as thousands of related and unrelated compounds, are used by the lubricating engineer in an attempt to improve certain conditions as well as to enhance certain necessary and specific qualities of lubricants. That the lubricating engineer has successfully met the lubricating problem before him is evidenced by the efficient operation and maintenance of our complex engines and machines. However, as is evident from the past history of the lubricating field, as well as the driving urge of science to improve and perfect existing materials and conditions, the field of lubrication may in the near future take on a new phase of development or open new and brighter horizons, producing new, novel, more potent, and more effective lubricants.

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Note: Numbers in parentheses after the patent numbers are the year in which the patents were issued; e.g. (38) is 1938.

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(61) U.S.P. 2348044 (44).
(62) U.S.P. 2349785 (44).
(63) U.S.P. 2350959 (44).
(64) U.S.P. 2355106 (44).
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(68) U.S.P. 2361746 (44).
(69) U.S.P. 2361957 (44).
(70) U.S.P. 2362624 (44).
(71) U.S.P. 2364283-4 (44).
(72) U.S.P. 2365209 (44).
(73) U.S.P. 2367468 (44).
(74) U.S.P. 2368000 (45).
(75) U.S.P. 2373094 (45).
(76) U.S.P. 2373811 (45).
(77) U.S.P. 2375060 (45), and U.S.P. 2375061 (45).
(78) U.S.P. 2377955 (45).
(79) U.S.P. 2379453 (45).
(80) U.S.P. 1976716 (34).
(81) U.S.P. 2138835 (38).
(82) U.S.P. 2157452 (39).
(83) U.S.P. 2157873 (39).
(84) U.S.P. 2167867 (39).
(85) U.S.P. 2174019 (39).
(86) U.S.P. 2188943 (40).
(87) U.S.P. 2191996 (40).
(88) U.S.P. 2203102 (40).
(89) U.S.P. 2208161-2 (40).
(90) U.S.P. 2215956 (40).
(91) U.S.P. 2231157 (41).
(92) U.S.P. 2233203 (41).
(93) U.S.P. 2235860 (41).
(94) U.S.P. 2246415 (41).
(95) U.S.P. 2260303-5 (41).
(96) U.S.P. 2262813 (41).
(97) U.S.P. 2263618 (41).
(98) U.S.P. 2270577 (42).
(99) U.S.P. 2285853 (42).
(100) U.S.P. 2289795 (42).
(101) U.S.P. 2293445 (42).
(102) U.S.P. 2301918 (42).
(103) U.S.P. 2315072 (43).
(104) U.S.P. 2321307 (43).
(105) U.S.P. 2331448 (43).
(106) U.S.P. 2339710 (44).
(107) U.S.P. 2343831 (44).
(108) U.S.P. 2346155 (44).
(109) U.S.P. 2354536 (44).
(110) U.S.P. 2363133 (44).
(111) U.S.P. 2369632 (45).
(112) U.S.P. 2370080 (45).
(113) U.S.P. 2373670 (45).
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The accompanying article is the third in a series of three articles appearing exclusively in the TECHNICAL SECTION of National Petroleum News, in which lubricating oil addition agents are grouped by chemical types and the patent history of the groups reviewed and their properties discussed.

The first two articles and date of their appearance were:

1. Sulfonic Derivatives as Lubricating Additives—Oct. 3, 1945
2. Sulfur and Sulfur Chloride Organic Reaction—Nov. 7, 1945

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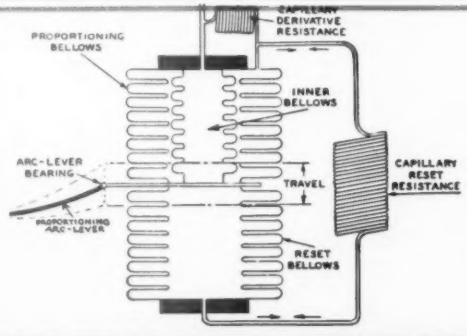

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INDUSTRIAL LUBRICATION

By W. G. Forbes

8—Tests and Specifications

W. G. Forbes, who had been contributing this regular feature to the *NPN Technical Section* since last May, was drowned July 29. He was Lubricating Engineer for the Tide Water Associated Oil Co., New York.

Before his death, however, Mr. Forbes had prepared a number of installments of his material in advance and submitted them to the editors. We will attempt to continue presenting his valuable contributions to the literature in the field of industrial lubricants and industrial lubrication as long as they are available.

Q—Define the term "Viscosity" and describe the methods employed to determine the viscosity of lubricating oils.

A—Viscosity is the resistance to motion offered by a fluid. Hence, slow pouring liquids have a high viscosity, and fast pouring liquids have a low viscosity.

The commercial instrument commonly used for determining viscosity in the United States is the Saybolt Universal Viscosimeter which is generally abbreviated S.U.V. and the test is carried out as follows:

The instrument is simply a small container which holds a little more than 60 cc. of oil. At the bottom there is a small orifice which has a bore of 0.1765 cm. and underneath is a receiving flask. The container is surrounded by a bath, and the oil to be tested is heated to any desired temperature, then the small orifice is opened, and the oil allowed to flow out. When 60 cc. have entered the lower flask, the time taken is clocked in seconds. This time is the viscosity reading of the oil. Hence the test is very simple.

Lubricating oils are generally tested for viscosity at two temperatures, 100° F. and 210° F. and recorded as follows:

Saybolt Viscosity at 100° F.	500 sec.
Saybolt Viscosity at 210° F.	65 sec.
or	
Viscosity (S.U.V.) at 100° F.	500 sec.
Viscosity (S.U.V.) at 210° F	65 sec.

With these two readings the viscosity at other temperatures may be found by plotting a straight line on a viscosity-temperature chart. These charts are printed by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. When two known points are marked on the chart they can be joined and extended by a line, and viscosities at other temperatures above the pour point read off from that line.

In other countries the readings are taken on similar types of flow instruments such as the Redwood instrument used in England. However, these instruments only differ in construction, the actual test procedure is the same and the various readings may be converted from one system to another by means of prepared tables.

Other units are also employed to record viscosity, such as centistokes and centipoises but these units are generally converted to Saybolt readings by means of prepared tables. The instruments employed to secure readings in centistokes are known as Kinematic Viscosimeters and they are used in laboratories because one man can operate about six of these Kinematic recording instruments at one time. They are also more accurate.

Q—What is meant by the S.A.E. Number of a Lubricant?

A—S.A.E. numbers were devised by the Society of Automotive Engineers for the convenience of the motoring public. This simple method of rating an oil by a viscosity limit has since been extended to aircraft engines, Diesel engines, and in many cases to general industrial applications. S.A.E. numbers eliminate lengthy instructions of a slightly technical nature which would be so much Greek to the general public. Hence automotive lubricants are rated and stamped at the refinery according to S.A.E. number.

The following is the schedule issued by the Society of Automotive Engineers:

S.A.E. No.	Saybolt Viscosity at 130° F. Min.	Saybolt Viscosity at 130° F. Max.	Saybolt Viscosity at 210° F. Min.	Saybolt Viscosity at 210° F. Max.
10	90	120		
20	120	185		
30	185	255		
40		255		80
50			80	105
60			105	125
70			125	150

The 10W and 20W ratings are not actually S.A.E. ratings but they are used as follows:

	Saybolt Viscosity at 0° F. Minimum	Saybolt Viscosity at 0° F. Maximum
10W	5,000	10,000
20W	10,000	40,000

GEAR OIL CLASSIFICATION

S.A.E. Number	Saybolt Viscosity	Consistency, must not channel in service at
80	100,000 at 0°F Max.	—20°F
90	800 to 1,500 at 100°F	0°F
140	120 to 200 at 210°F	35°F
250	200 at 210°F Min	...

From the above tables, it will be noticed that motor oils are numbered from 10 to 70 and gear lubricants are numbered 80, 90, 140 and 250. From this sequence it might be assumed that all gear oils are heavier and more viscous than all motor oils, but this is not so. The following table shows an approximate comparison of the S.A.E. numbers that overlap.

COMPARISON OF S.A.E. NUMBERS

S.A.E. Numbers for Gear Oils (See Note)	Equivalent S.A.E. Numbers for Motor Oils
80	30
90	40 and 50
140	70
250	Heavier than any Motor Oil

Note. This table of comparison does not take into consideration the qualification of channeling applied to gear oils. However, an S.A.E. 30 Motor Oil with a pour point of —20° F. would probably meet the requirements of an S.A.E. 80 gear oil, and S.A.E. 40 Motor Oil with a pour point of 0° F. would probably meet the requirements of an S.A.E. 90 gear oil.

S.A.E. numbers are based on viscosity limits only. They have no bearing on quality or other considerations that enter into the manufacturing of lubricating oils.

Q—What precautions should be taken when changing from a straight mineral oil to a detergent oil?

A—When a changeover from straight mineral to a detergent oil is being made, or anticipated, care should be taken to see that the engine is reasonably clean. If the engine is known to harbor deposits, the dispersive action of a detergent oil will loosen up a certain amount of the clinging deposits and may result in blocking the oil screen, or plugging an oil lead to the bearings. Detergent oils are not generally capable of completely dispersing these loose deposits, but may well loosen up a sufficient quantity to promote a hazard in the crankcase.

Hence, dirty engines should be run for 100 miles or so on the first charge of detergent oil, or run idle for two hours. During this period the oil gauge must be watched to detect the possibility of clogging the oil screen and preventing proper circulation of the oil.

After this initial run-in period the oil charge should be renewed two or three times at increasing mileages, and at some time during this stage of the changeover it may be found advantageous to drop the oil pan. In any event the oil should be drained while hot in order to freely discharge the deposits.

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R-1013

Vapor Phase Oxidizing Cracking of Oil Products

By L. I. Berents and V. E. Glushnev

This is the second and concluding installment of a translation from the Russian scientific literature, in which the authors discuss the effect of cracking hydrocarbons in the presence of air. Such oxidizing cracking, they claim, gives a high extent of conversion of the charge. They also state that increased yields of aromatics can be achieved at lower temperatures than those required in ordinary cracking. The first installment appeared in the Nov. 7 issue, pg. R-912.

The translation is by Dr. J. G. Tolpin of the Universal Oil Products Co., Chicago. Facts and opinions presented are solely those of the original authors, and neither Universal Oil Products Co. nor the Petroleum Division of the American Chemical Society (through whose cooperation these translations are made available) necessarily endorses the statements made.

The dependence of the volume of the hydrocarbon portion of the cracked gases, i.e., the total gas, subtracting carbon monoxide, carbon dioxide, free oxygen and nitrogen, upon the concentration of oxygen and temperature, as shown in Fig. 8, also supports the view that the decomposition of the hydrocarbon proceeds the more vigorously, the higher is the oxygen content of the charge within the limits studied. The formation of the fraction with 225° end point per unit time (Fig. 9) also increases with rise of the concentration of oxygen, within 15 to 50 mole-%. Finally, in Table 7 data are given on the rise of the cracking velocity with increase of the concentration of oxygen from 0 to 48 mole-%. Thus, it is beyond doubt that oxygen initiates the decomposition of the hydrocarbon chain and it is probable that substances of peroxide character, formed as a result of primary decomposition of the hydrocarbon and interaction with oxygen, serve as the source of activation and initiation of new chains.

The influence of the temperature on oxidation is represented by Fig. 10, in which the total consumption of oxygen is shown in the formation of carbon monoxide, carbon dioxide, water and liquid oxygenated compounds, designated as $C_xH_yO_z$, which were determined by difference, as well as the percentage of unconsumed oxygen found in cracked gases. The amount of oxygen spent in the formation of liquid oxygenated compounds was computed by subtracting from the total amount of oxygen charged that amount of it which was spent in the formation of carbon monoxide, carbon dioxide and water, as well as the amount of free oxygen found. The oxygen consumed in the formation of the sum of carbon monoxide and carbon dioxide is seen to increase with rise of the temperature, reaching a maximum of 40% at 700°. On the other hand, the consumption of oxygen in the formation of liquid oxygenated compounds and water decreases with rise of the temperature from 76-78.5% at 540°C. to 44-52% at 700°. This can be explained by the progressing decomposition of compounds such as aldehydes, ketones and, possibly, alcohols to carbon dioxide, carbon monoxide and, to some extent, water with rise of the temperature.

Cracking of gas oil. In the experiments of oxidizing cracking of gas oil the process of aromatization was clearly manifested. The reactor used in this series of experiments was almost ten times larger than that of the ordinary laboratory type reaction tube, about 5,000 ml. against 440 ml. The results of these experiments are shown in Tables 8, 9, 10 and Fig. 11. The highest yields of the sum of aromatics, exceeding 11%, was obtained at the relatively low temperature of 530-550°C. Accumulation of individual aromatics is shown in Fig. 11. The maximum for any of these compounds differs from the maxima for the others. Consequently, formation of benzene, toluene and xylene in oxidizing cracking of gas oil proceeds as parallel processes up to a certain maximum, after which a portion of toluene is formed by conversion of xylene and some benzene is formed by demethylation of toluene. This does not preclude, however, the possibility of formation, for instance, of benzene and toluene by condensation of olefins with dienes[15].

Gasolines with substantial contents of aromatics can be obtained by oxidizing cracking, and Table 8 shows that at 520-550°C. the yield of 150°C. end point gasoline may reach 16.6% on the charge and contain from 60 to 65% benzene, toluene and xylene, while the gasoline boiling up to 225°C. may be obtained in yields of 22-25% with a content of low molecular aromatics reaching 47-50% (Expts. 5 and 6). The residual 40-50% will consist of unsaturated, predominant-

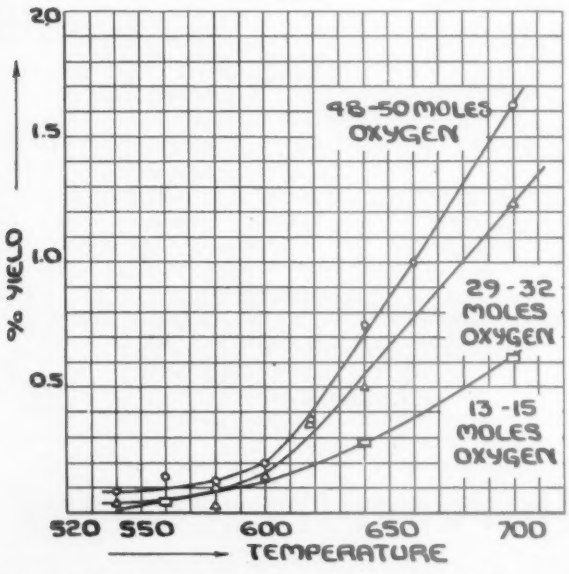


Fig. 8—Yield of the hydrocarbon portion of the gas per 1 sec. reaction period

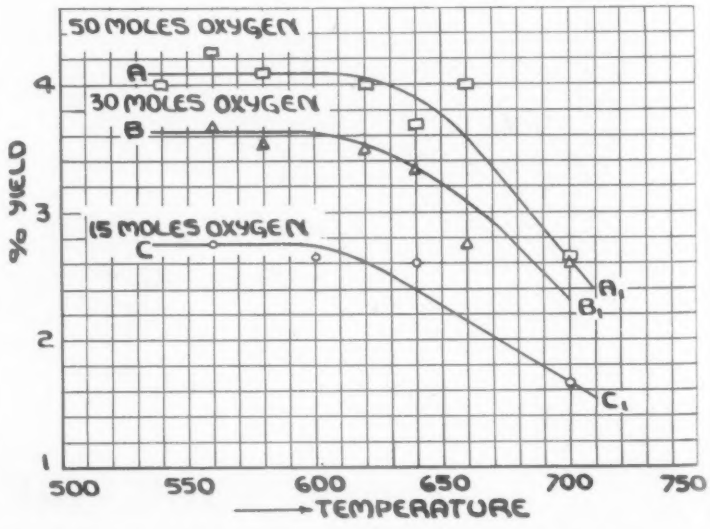


Fig. 9—Effect of the temperature and concentration of oxygen on the yield of the fraction with 225° C. end point per 1 sec. of the reaction period

TABLE 9—Oxidizing Cracking of Gas Oil

Expt. No.	1	2	3	4	5	6	7	8	9	10
Reaction temp., °C.	440	450	460	480	500	520	550	550	550	600
Content of oxygen, mole % on charge	41.8	42.0	40.0	41.9	43.2	60.8	51.2	50.0	18.8	46.8
Heating period, sec.	40.07	38.13	38.5	33.43	26.66	48.67	20.4	11.0	36.0	18.90
Fraction with 225° C. E.P.										
% by wt. on the charge	27.8	30.5	24.27	25.53	24.9	21.87	21.2	23.5	18.9	15.0
d (15/4)	0.7905	0.8135	0.830	0.8427	0.8550	0.8883	0.884	0.8023	0.8760	0.8920
Fraction 225-275° C.										
% by wt. on the charge	14.63	13.1	7.37	6.8	6.07	4.73	4.71	(§)	20.4	.....
d (15/4)	0.8686	0.8900	0.9063	0.9435	0.948	1.030	0.979	(§)	0.8875	.....
Fraction above 275°										
% by wt. on the charge	33.86	22.7	12.0	12.64	12.2	12.6	11.4	(§)	27.6	11.11
d (15/4)	0.9164	0.969	1.0017	1.0441	1.0652	1.066	1.1730	(§)	0.935	1.1740
Gas										
Sp. gr. at 0° and 760 mm. pressure	0.9583	0.9879	0.9159	0.9788	0.9221	0.9051	0.8465	(§)	.....	0.6805
% by wt. on the charge	16.1	18.0	24.0	31.6	42.2	64.06	55.6	(§)	.....	50.0
Hydrocarbon*	7.14	8.11	13.2	22.26	30.2	36.64	39.5	(§)	.....	31.7
Oxygenated†	1.36	1.69	2.15	2.21	1.56	3.62	2.03	(§)	.....	3.55
Nitrogen‡	7.6	8.14	8.65	6.6	11.1	13.8	13.4	(§)	.....	14.6

*Hydrocarbon portion, % by wt. on the charge. †Oxygenated portion, % by wt. on the charge. ‡Nitrogen, % by wt. on the charge. §The residue over 225° C. was not fractionated.

TABLE 10—Oxidizing Cracking of Gas Oil

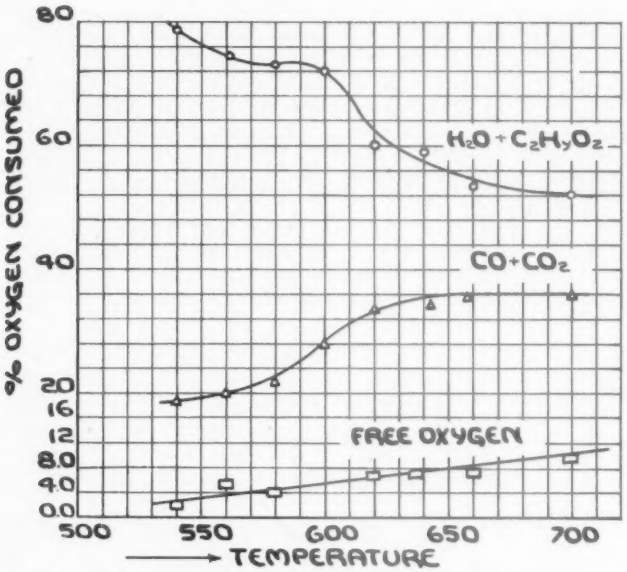
Expt. No.	1	2	3	4	5	6	7	8	9	10	11
Fraction with 70° C. E.P.											
d (15/4)	0.7064	0.7113	0.7052	0.6902	0.7391	0.7693	0.7736	0.7124	0.7211	0.7657	0.7232
Yield*	16.4	20.7	13.6	14.2	17.2	2.3	4.8	27.8	16.6	2.3	6.6
Benzene fraction, 70-95° C.											
d (15/4)	0.7443	0.7741	0.7692	0.8022	0.8068	0.8440	0.8460	0.7874	0.7878	0.8554	0.8210
Yield*	22.4	21.1	11.7	32.8	27.3	36.8	48.4	15.1	29.7	44.3	28.1
Benzene											
% by wt. on the fraction 70-95°C.	...	18.5	35.4	37.4	56.2	78.0	73.8	49.8	33.8	85.6	44.4
Yield*	...	3.9	3.84	12.28	15.34	28.7	35.7	7.5	10.03	37.9	12.6
% by wt.†	...	2.49	2.62	8.25	11.99	22.0	28.0	5.0	7.7	32.6	8.8
% by wt. on the charge	...	0.75	0.66	2.1	2.98	4.81	6.93	1.15	1.45	5.0	13.3
Toluene fraction, 95-122° C.											
d (15/4)	0.7611	0.7869	0.8003	0.8283	0.8288	0.8524	0.8520	0.8107	0.8116	0.8463	0.8427
Yield*	32.3	33.0	41.2	31.5	33.5	43.4	30.5	28.6	30.5	38.1	38.1
Toluene											
% by wt. on the fraction 95-122°C.	2.2	17.9	29.5	60.9	51.8	59.8	63.6	55.7	46.2	68.3	70.8
Yield*	0.71	5.9	12.5	19.18	17.35	25.95	19.4	15.9	14.1	26.02	27.0
% by wt.†	0.16	3.77	7.78	12.9	13.56	19.9	16.2	10.57	10.8	22.3	18.8
% by wt. on the charge	0.04	1.15	1.88	3.29	3.47	4.35	3.43	2.48	2.04	3.35	2.8
Xylene Fraction, 120-150° C.											
d (15/4)	0.7960	0.8178	0.8150	0.8474	0.8408	0.8650	0.8660	0.8319	0.8301	0.9000	0.8529
Yield*	27.0	22.3	31.5	20.5	20.5	17.0	15.6	14.9	22.6	14.9	25.7
Xylene											
Yield*	7.7	9.8	22.4	11.4	11.59	10.79	4.10	14.66	11.91	3.99	15.13
% by wt.†	1.80	6.30	14.70	7.67	9.06	8.29	3.20	9.73	9.13	3.40	10.54
% by wt. on the charge	0.29	1.90	3.10	1.95	2.26	1.80	0.68	2.29	1.73	0.41	1.59
Benzene + Toluene + Xylene											
Yield*	8.41	19.6	3.74	42.86	44.28	65.44	59.20	38.10	46.00	67.90	54.70
% by wt.†	1.96	12.56	25.10	28.80	34.60	50.20	47.40	25.30	27.60	58.30	38.14
% by wt. on the charge	0.33	3.70	5.64	7.34	8.95	10.96	11.04	6.03	5.21	8.74	6.72
% by wt.‡	0.0082	0.0986	0.1455	0.2180	0.334	0.227	0.275	...	.....	0.462	.....

*Yield, % by wt. on the fraction with 150° C. E.P. †% by wt. on the fraction with 225° C. E.P. ‡% by wt. on the charge formed per 1 sec. reaction period.

TABLE 11—Oxidizing Cracking of Surakhany Mazut

	EXPERIMENTAL SERIES NO. 1						EXPERIMENTAL SERIES NO. 2				
Expt. No.	1a	2	3	4b	5	6a	7	8	9a	10	11b
Reaction Temp., °C.	540	580	620	640	680	720	620	620	620	620	620
Evaporation Temp., °C.	420	420	420	420	420	420	420	420	420	420	420
Rate of flow, g./hr.	88.76	88.86	88.76	88.76	88.7	88.76	44.38	44.38	88.71	133.10	266.90
Air, liters/hr.	0.2	0.2	0.2	0.2	0.2	0.2	0.42	0.20	0.20	0.20	0.2
REACTION PRODUCTS											
Fraction with 150° C. E.P.											
d(15/4)	...	0.7640	0.7870	0.8004	0.7960	0.8530	0.8060	0.7821	0.7870	0.7850	0.7640
Yield*	...	9.46	12.0	12.0	10.2	7.7	8.6	17.0	12.0	13.6	4.9
Fraction with 200° C. E.P.											
d(15/4)	0.7750	0.7790	0.7794	0.8115	0.8050	0.8590	0.8130	0.8069	0.7794	0.7860	0.7740
Yield*	6.8	13.7	16.8	15.2	13.7	8.9	13.2	25.9	16.8	17.8	7.5
Fraction 200-300° C.											
d(15/4)	0.8570	0.8610	0.8994	0.9308	0.9050	0.9450	0.8130	0.8069	0.7794	0.7860	0.7740
Yield*	16.2	16.2	13.6	7.6	8.75	6.2	9.7	10.0	13.5	11.1	12.5
Gas											
Sp. gr., at 0° C. & 760 mm.	0.9493	0.9374	0.8756	0.8945	0.8640	0.8520	0.9026	0.8641	0.8756	0.8905	0.9352
Hydrocarbon†	1.21	5.58	23.3	25.2	27.0	30.1	34.3	20.5	23.3	20.8	12.13

*Yield, % by weight on the charge. †Hydrocarbon portion, % by weight on the charge.



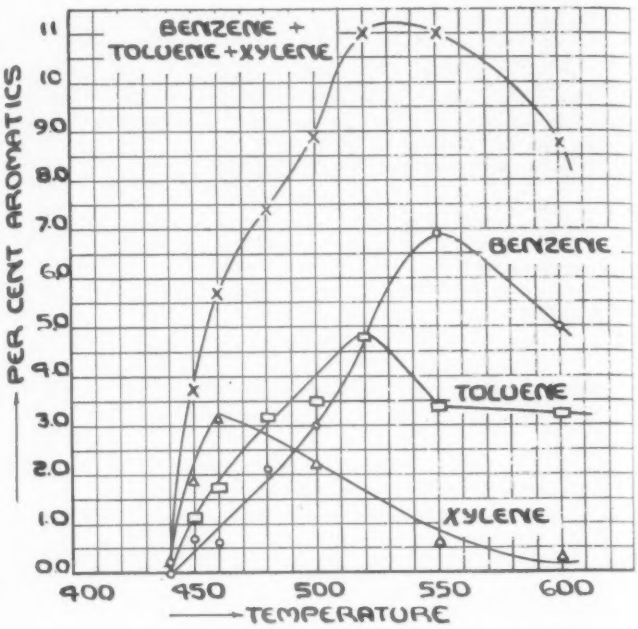


Fig. 10—Effect of the temperature on the oxidation reaction. Fig. 11 (right)—Effect of the temperature on the yield of low molecular aromatics

ly cyclo-olefins with 5 and 6 carbon atoms and dienes.

Assertions are sometimes made that formation of aromatics in oxidizing cracking of petroleum is a result of the dehydrogenating action of oxygen of the air on naphthenes, and witness to this is the fact that water is formed. It seems to the present authors that the cause of the vigorous reaction of formation of aromatics and cyclo-olefins should be sought elsewhere. The oxygen brings about at high temperatures a decomposition of long paraffin chains as well as alicyclic side chains, which behave similarly under these conditions. According to Terent'ev, Gal'pern and Vinogradova[18] the content of diolefins in narrow gasoline cuts obtained by oxidizing cracking at 575-580° is:

Fraction, °C.	Percent
33-35.5	17.7
63.5-67	12.6
76.5-80	24.7
77.5-82	23.4
106-111.5	12.9

Thus, short chain olefins and dienes are formed in this decomposition which apparently serve as the source of formation of aromatics by condensation. The work of Davidson[15], of Staudinger, Hague and Wheeler[16], of I. Ivanov[17] and others leaves no longer any doubt that aromatic hydrocarbons can be formed in the course of pyrolysis of olefins; to the intermediate stage, consisting of formation of dienes, an important part of this synthesis is accorded.

Formation of olefins under the action of oxygen in the course of oxidizing cracking greatly exceeds the amount of olefins formed in pyrolysis, and especially in ordinary cracking, which undoubtedly favors formation of aromatics and cyclo-olefins. However, extensive cyclization in oxidizing cracking at relatively low temperatures of 540-550°C. is possible only under conditions of prolonged heating of the hydrocarbon-air mixture. This is confirmed to some extent by the experiments of oxidizing cracking of gas oil. A decrease in the duration of the reaction, other conditions being equal, leads to an increase of the content of oxygenated compounds in the cracked gasoline and a decrease of its content of cyclic compounds, particularly aromatics. As mentioned above, an increase of the concentration of oxygen up to a certain limit accelerates the decomposition of paraffins to unsaturated, and thus promotes formation of cyclic compounds. The influence of these two factors, air and duration of the reaction, is complementary, and the sum of these effects on the conversion of the hydrocarbon charge is similar to that of a pronounced rise of the temperature in ordinary cracking.

Cracking of Surakhany mazut. Surakhany mazut was pyrolyzed with the view of determining the effect of temperature and duration of the reaction on the yield of low molecular aromatics and on the extent, character and conditions of coke formation. The physical constants of the charging stock are shown in Table 2 and the conditions and results of the experiments in Tables 11, 12 and 13. The highest yield of cracked gasoline boiling below 200°C. amounts to 16.8% on the charge (Table 11 and Fig. 14), and this yield was achieved at 620°C. and a charging rate of 88.7 g. per hour. Under these conditions the aviation gasoline with 150° end point amounts to 12%. However, when the rate of charging is reduced to one half, i.e., 44.4 g. per hour, at the same temperature the yield of the 200°C. end point fraction rises to 26% on the charge and that of the 150° end point fraction to 17%.

The changes in the chemical composition of the 150° end point fraction and of its yield with temperature and duration of the reaction are seen from Figs. 12 and 13, which are based on the data of Table 12. With rise of the temperature the content of unsaturates in this gasoline continuously decreases (Fig. 12). On the other hand, an increase of the temperature enhances the aromatization (Fig. 13). It follows, however, from Fig. 14 that the process of formation of low molecular aromatics is not uniform in this case. At lower temperatures xylene is formed in amounts exceeding those of the other low molecular aromatics; then follows toluene, and, further, benzene. When the temperature

TABLE 12—Oxidizing Cracking of Surakhany Mazut

Expt. series	Expt. No.	Sp. gr. d(15/4)	Cracked gasoline with 150°C. E.P. % by wt. on the charge	Total low molecular aromatics, % by wt.	Unsaturated Hydro-carbons, % by wt.
I	2	0.7640	9.5	15.88	58.5
	3	0.7870	12.0	31.66	53.8
	4b	0.8004	12.0	44.80	47.9
	5	0.7960	10.2	38.46	40.5
	6a	0.8520	7.7	57.90	30.0
II	7	0.8060	8.6	43.12	50.6
	8	0.7821	17.0	38.58	42.0
	9a	0.7870	12.0	33.66	53.8
	10	0.7850	13.6	24.90	60.2
	11b	0.7640	4.9	19.63	73.9

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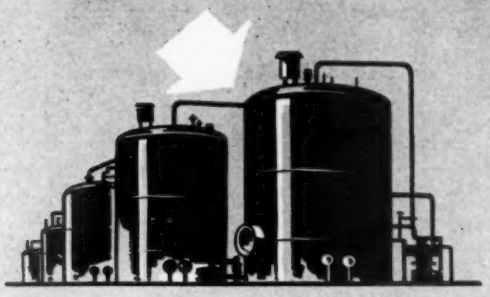

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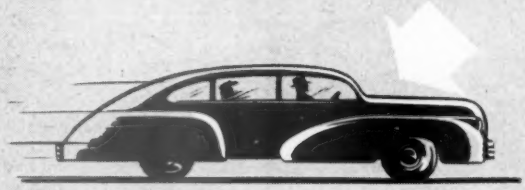

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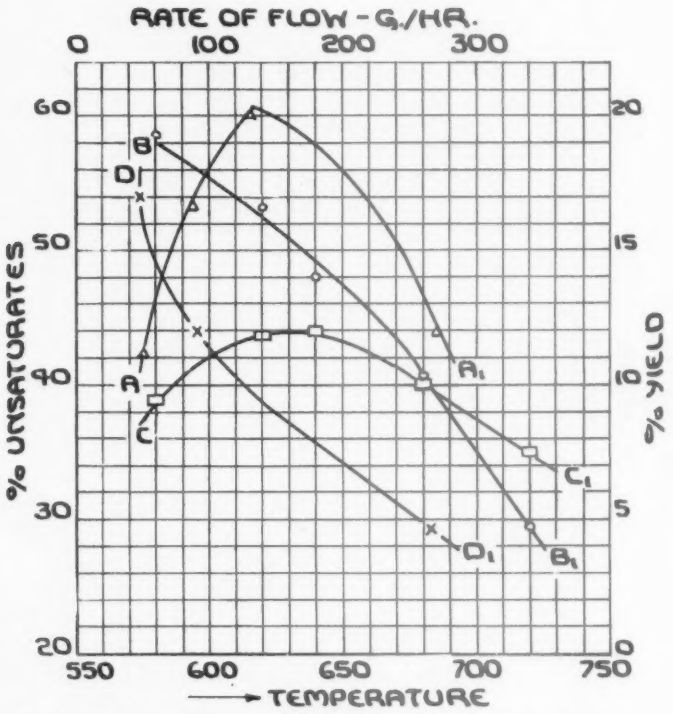

Fig. 12—Effect of the temperature and the period of pyrolysis on the yield of the fraction with 150° C. E. P. and on the content of unsaturated in this fraction. Curve A-A_1: dependence of the yield of unsaturated hydrocarbons upon the rate of flow. Curve B-B_1: dependence of the yield of unsaturated hydrocarbons upon the temperature of pyrolysis. Curve C-C_1: dependence of the yield of the fraction with 150° C. E. P. upon the temperature of pyrolysis. Curve D-D_1: dependence of the yield of the fraction with 150° C. E. P. upon the rate of flow of the charge

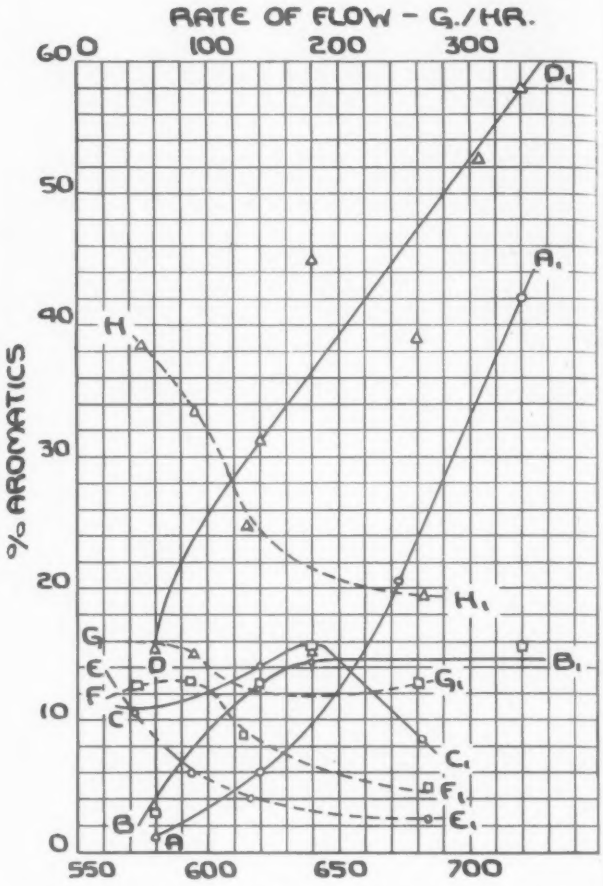

Fig. 13 (right)—Effect of temperature and pyrolysis period (rate of flow) at 600° C. upon the content of aromatics in the fraction with 150° C. E. P. Curve A-A_1: benzene. Curve B-B_1: toluene. Curve C-C_1: xylene. Curve D-D_1: total benzene plus toluene plus xylene. Curve E-E_1: benzene at 600°. Curve F-F_1: toluene at 600°. Curve G-G_1: toluene. Curve H-H_1: total benzene plus toluene plus xylene at 600°

TABLE 13—Oxidizing Cracking of Surakhany Mazut

Experiment Series	1					2				
Experiment no.	2	3	4b	5	6a	7	8	9a	10	11b
Fraction with 60° C. E.P.										
d(15/4)	0.7073	0.7264	0.7322	0.7296	0.7516	0.7290	0.7256	0.7264	0.7184	0.7030
Yield*	18.6	20.8	22.8	18.9	8.3	14.7	19.1	20.1	20.8	21.2
Benzene Fraction, 70-95° C.										
d(15/4)	0.7542	0.7915	0.8132	0.7910	0.8580	0.7984	0.7955	0.7915	0.7668	0.7607
Yield*	26.1	27.7	28.7	42.0	57.5	24.2	27.1	27.7	28.7	29.0
% by wt. benzine										
On the fraction with 150° C. E.P.	1.16	5.97	14.4	15.4	42.1	9.0	10.4	6.0	4.2	2.3
On the fraction with 200° C. E.P.	0.8	4.26	11.38	11.4	36.3	5.88	6.85	4.26	3.19	1.69
On the charge	0.11	0.71	1.72	1.57	3.23	0.78	1.77	0.71	0.57	0.11
Toluene Fraction, 95-122° C.										
d(15/4)	0.7831	0.8207	0.8341	0.8292	0.8631	0.8290	0.8178	0.8207	0.8024	0.7909
Yield*	28.5	30.2	27.7	22.9	21.0	26.0	26.1	30.2	28.6	20.7
% by wt. toluene										
On the fraction with 150° C. E.P.	3.4	13.0	15.7	13.3	15.8	17.3	12.3	13.0	8.8	4.5
On the fraction with 200° C. E.P.	2.35	9.27	12.45	9.90	13.60	11.30	8.08	9.27	6.70	2.10
On the charge	0.32	1.55	1.89	1.35	1.20	1.49	2.09	1.55	1.18	0.21
Xylene fraction, 122-150° C.										
d(15/4)	0.8035	0.8334	0.8450	0.8432	0.8673	0.8400	0.8398	0.8334	0.8224	0.8091
Yield*	25.6	17.2	19.3	12.5	13.2	27.7	18.9	17.2	20.2	22.9
% by wt. xylene										
On the fraction with 150° C. E.P.	11.3	12.6	14.7	9.6	...	16.8	15.8	14.7	11.9	12.83
On the fraction with 200° C. E.P.	7.8	9.0	11.6	7.44	...	10.9	10.4	11.6	9.0	8.36
On the charge	1.07	1.50	1.76	1.01	.	1.44	2.09	1.76	1.60	0.62
% by wt. benzine + toluene + xylene										
On the fraction with 150° C. E.P.	15.88	31.56	44.80	38.46	57.9**	43.12	38.58	33.66	24.90	19.63
On the fraction with 200° C. E.P.	10.97	22.52	35.43	28.80	49.90**	28.10	25.33	25.13	18.90	12.15
On the charge	1.5	3.76	5.37	3.93	4.43	3.71	5.95	4.02	3.35	0.94

* Yield on the fraction with 150° C. E.P.
** Without xylene.

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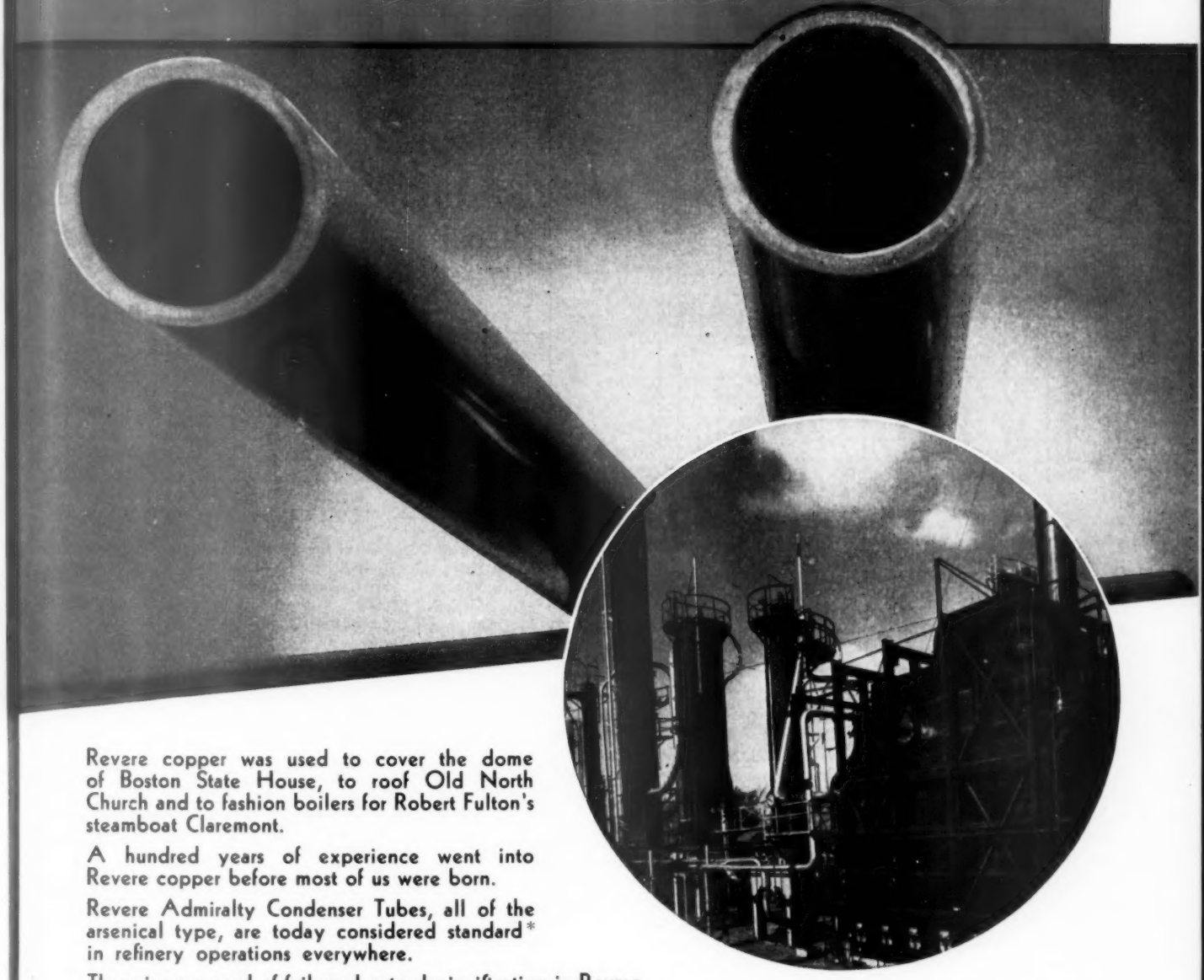

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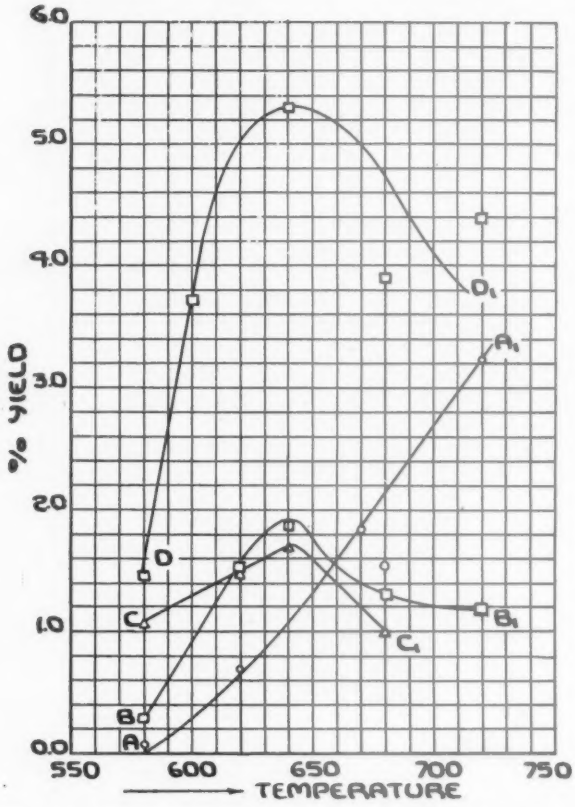

Fig. 14—Effect of the temperature of pyrolysis on the yield of aromatic hydrocarbons. Curve A-A_1: benzene. Curve B-B_1: toluene. Curve C-C_1: xylene. Curve D-D_1: total benzene plus toluene plus xylene

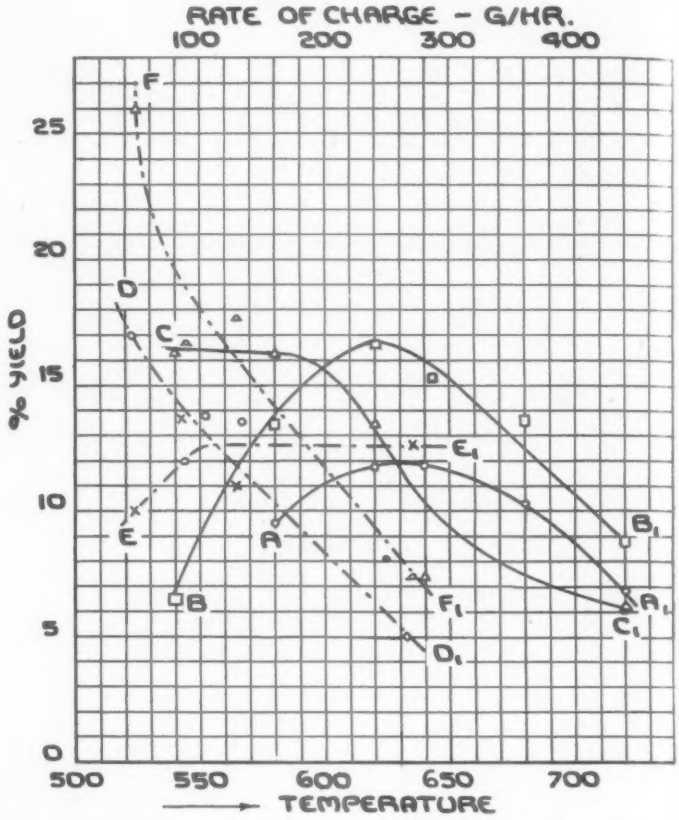

Fig. 15 (right)—Dependence of the yields of the fractions with 150°C. E. P., 200° C. E. P., and 200-300° C. upon the temperature and duration of the pyrolysis of Surakhany Paraffinic Mazut at 600°. Curve A-A_1: fraction up to 150°. Curve B-B_1: fraction up to 200°. Curve C-C_1: fraction 200-300°. Curve D-D_1: fraction 150° C. E. P., at 600°. Curve E-E_1: fraction 200-300° at 600°. Curve F-F_1: fraction with 200° C. E. P. at 620°

of pyrolysis rises the content of xylene slightly increases until the temperature of 640° is reached, when it shows a sharp drop. However, the curve for the content of toluene, which also increases up to 640°, later runs parallel to the abscissa, while that of benzene continues to increase up to 720°. Similarly to cracking of gas oil, conversions of hydrocarbons are revealed characteristic for oxidizing cracking and leading to accumulation of aromatics.

Judging from the intersecting curves possessing different maxima, it may be said that in pyrolysis of mazut demethylation of aromatics also occurs, leading to conversion of xylene to toluene and the latter to benzene. However, as a parallel feature condensation of olefins with dienes to aromatics probably takes place. It is seen from Fig. 12 that with rise of the temperature of pyrolysis the content of olefins in the 150°C. end point gasoline drops from 58% at 580° to 29% [at 730°]. Simultaneously, the content of aromatics in the 150° end point fraction is shown by Fig. 13 to increase. It is thus clear that increase of the temperature facilitates accumulation of aromatics to a certain extent also at the expense of unsaturates. The dependence of the yield of gasoline and kerosene upon temperature is shown in Fig. 15. The absolute yields of aromatics were found not to exceed those usually obtained by pyrolysis in retorts without air. The yields of aromatics as reported here are lower than the actual, due to the losses with the gases, caused by the imperfection of the absorption system.

In conclusion, it may be noted that coke deposition was either not observed in any of the experiments reported or was negligible. Formation of carbon black was also insignificant, and only a very thin layer of it was deposited on the walls of the reactor. However, when mazut was cracked under the same conditions without the presence of air, coke was formed to an extent which brought about complete clogging of the apparatus. This exceedingly low coking in the experiments under report is to be explained by the nitrogen of the air acting as an inert diluent and apparently hindering secondary processes of condensation, leading to coke formation.

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In the experimental part of this work T. N. Protopopova participated.

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Petroleum Technologists in the Headlines

Mr. Benz

Mr. Thomas

Ross W. Thomas has been appointed executive assistant to G. G. Oberfell, vice president of Phillips Petroleum Co., with the title of manager of research and development. **Geo. R. Benz** succeeds him as manager of the Chemical Products Department.

Mr. Thomas started with the Phillips company as construction superintendent in 1926 and later became research engineer on liquefied petroleum gases. Following a year as assistant director of research, he was made vice president and general manager of the subsidiary Philgas Co. Subsequently the Chemical Products Department was set up to include Philgas, among other activities. Since 1940 Mr. Thomas has also been president of Hycar Chemical Co., the affiliate owned jointly by Phillips Petroleum and B. F. Goodrich Co. to manufacture and market synthetic rubber.

Mr. Benz started with Phillips in 1925 in the engineering department; in 1927 he became interested in LPG activities and in 1928 transferred to the Detroit office as sales engineer, later becoming industrial division manager of Philgas. In 1940 he was made assistant manager of Phillips Chemical Products Department.

* * *

Dr. Thomas

Dr. Charles L. Thomas has been appointed director of research of Great Lakes Carbon Corp. and **Dr. L. C. Swallen** assistant director. Dr. Thomas has spent 14 years in the research and development laboratories of the Universal Oil Products Co. He is a graduate of the University of North Carolina and received his doctor's degree at Northwestern. He is vice chairman of the Petroleum Division of the American Chemical Society and also a vice chairman of the Chicago Section of the ACS.

Dr. Swallen came to Great Lakes Carbon Corp. three years ago and had previously been with Corn Products Refining Co. He received his doctor's degree at Ohio State University. The research and development division of Great Lakes Carbon Corp. is located in Morton Grove, Ill., a Chicago suburb.

* * *

J. D. Hall, formerly manager of catalysts sales for the Harshaw Chemical Co. has resigned to form the Hall Chemical Co. The new firm will make and sell metallic salts and catalytic chemicals.

* * *

James H. Graham, director of the Natural Gas and Natural Gasoline Division of PAW in the early part of the war, has joined the Continental Oil Co., with headquarters in Ponca City. He will be superintendent of the unitization program recently inaugurated by the company.

Mr. McConnell

Mr. Metz

Elliott B. McConnell, Cleveland, has been advanced to the new position of general manager of the manufacturing department, Standard Oil Co. (Ohio), under G. W. Hanneken, vice president of manufacturing. He will also be in charge of the Technical Service, Chemical Research, General Engineering and Fuels and Lubricants Service divisions. His title formerly was assistant to Vice President Hanneken. Mr. McConnell was chairman of the codimer subcom-

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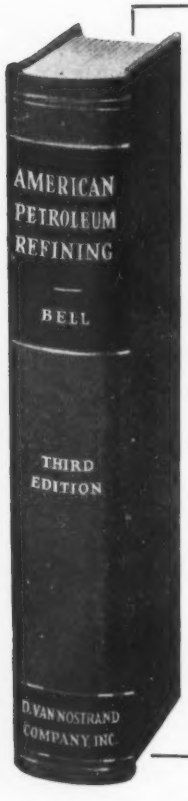

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mittee of the Aviation Gasoline Advisory Committee of PIWC during the war.

Richard S. Stewart, formerly secretary of the manufacturing committee, Standard of Ohio, will be under Mr. McConnell as plant operations manager. The refineries will report to him and in the new setup of personnel in the manufacturing department, he will supervise the Refining Control and Maintenance Control divisions of the company.

Among other changes in technologist personnel announced by Sohio are the following:

C. H. Metz, Jr., formerly manager of the No. 1 refinery in Cleveland, becomes director of industrial relations for the company. Graduating from the Citadel at Charleston, S. C., in 1922, Mr. Metz began working for the Standard Oil Co. of New Jersey in Charleston. He spent three years in Tampico, Mex., and came to Cleveland in 1927 as a cracking coil stillman at the No. 1 refinery. He was made coil foreman and in 1929 assistant superintendent. In 1937 he was named superintendent and with its expansion last fall filled the newly created position of manager.

J. R. Cuthbert, formerly superintendent of Sohio's Lima, O., refinery, succeeds Mr. Metz as manager of the No. 1 refinery. Mr. Cuthbert represents the third generation of his family in the petroleum industry, his grandfather having owned a small refinery 75 years ago. After taking a specialized course in chemistry at the Rensselaer Polytechnic Institute, he joined the Grasselli Chemical Co. in Cleveland in 1920. He later operated an industrial laboratory in Lima and in 1925 joined Solar Refinery Co. of Lima, later purchased by Standard Oil.

Mr. Peterson

Mr. Cuthbert

I. L. Peterson, at present superintendent of maintenance and construction at the No. 1 refinery, goes to Lima as Mr. Cuthbert's successor. He graduated from the University of Illinois in 1924 and went to work in Sohio's Toledo refinery as a draftsman. After holding various positions there he was transferred to the company's home office in Cleveland in 1936 as assistant to G. W. Hanneken, vice president in charge of manufacturing. He was later assistant superintendent of the No. 1 plant and in 1944 was made superintendent of maintenance and construction.

E. S. Bale has been named superintendent of the No. 1 refinery and will assume Mr. Peterson's responsibilities as well as those he has previously held as superintendent of processing. He graduated from Case School of Applied Science in 1934 and was for five years in the technical service division of Standard Oil Co. of New Jersey. He joined Sohio in 1939 as process engineer at the Toledo refinery and was later transferred to Cleveland, first as chief of the technical service section of the manufacturing department.

Mr. Bale

Mr. O'Rourke

Edward V. O'Rourke, professor of petroleum engineering at Ohio State University, will leave this position at the end of the present term and, starting Jan. 1, will be director of the new Edwy R. Brown School of Petroleum, at Marietta College, Marietta, O. His research in the field of secondary oil recovery gives him special qualifications for directing the work of the petroleum school, which will emphasize work in increasing the recovery from oil producing structures. A graduate of Ohio State in mining engineering in 1919, Mr. O'Rourke has done exploratory work in the oil fields and mining districts of this country and Venezuela and has been associated with several of the major oil companies. The petroleum school at Marietta was endowed by the will of the late Edwy R. Brown, who was chairman of the board, Magnolia Petroleum Co.

° ° °

G. R. Monkhouse has returned to Shell from a military leave of absence and has been named general manager of the eastern division of the Shell Chemical Division of Shell Union. He has been with the Shell company since 1929, working in various marketing divisions as well as in the president's office. He left the position of manager of the Minneapolis marketing division to enter military service.

° ° °

Comm. A. Ernest MacGee, officer in charge of the chemistry section of the research and standards branch of the U. S. Navy Bureau of Ships during the war, has returned to Skelly Oil Co. as head of the solvents department. Dr. MacGee also was chairman of the laboratory committee which was in charge of the bureau's administration of laboratories and the direction of certain research and development projects.

V. V. St. L. Tivy, formerly with the M. W. Kellogg Co., has recently been appointed assistant manager of the Oil and Gas Industries Sales Division of the Foxboro Co., instrument manufacturers. Previous to being with Kellogg, Mr. Tivy was with an English instrument firm, and later with the Neal & Massy Engineering Co., Ltd., at Trinidad, B.W.I. He is at Foxboro's home offices in Foxboro, Mass.

Another recent Foxboro appointment is **Nels A. Swanson**, formerly electrical and instrument engineer for the Goodyear Synthetic Rubber Corp. at Torrance, Calif., as sales engineer in Foxboro's Los Angeles branch office. Mr. Swanson supervised much of the instrumentation of Goodyear's plant at Houston.

° ° °

Among newcomers in the Research Department of the Standard Oil Co. (Indiana) at Whiting are the following:

Julius J. Krauklis, formerly instructor in chemical engineering at Cornell University, has assumed duties in the process laboratories.

Louis D. Scott has come to the technical service division from the G. D. Searle Co.

James T. Corcoran is a new member of the analytical department.

Harold Ahlberg will engage in personnel work in the analytical department.

Joseph Royal, formerly with the metallurgical laboratory, University of Chicago, is now engaged in heavy oils research.

° ° °

R. M. Prather has joined the recently organized chemical products department of the Standard Oil Co. of Indiana, to be in charge of market-research activities. A chemistry graduate of Rutgers university, Mr. Prather was formerly with the Westvaco Chlorine Products Corp.

° ° °

Col. Martin B. Chittick, manager of specialty and technical sales, Pure Oil Co., has received the Army's Legion of Merit award for his services overseas in technical intelligence work. Col. Chittick is a charter member of the group which organized the present Chemical Warfare Service of the Army and he has been in military service since 1917. He was called to active duty in 1941 as Chief, Engineering Branch, Office Chief Chemical Warfare Service, and later was Deputy Chief, Technical Division. In 1943 he became commanding officer at Camp Detrich, Frederick, Md., and a year later went overseas in technical intelligence work.

Col. Chittick

Mr. Webber

Mr. Pew

James E. Pew has been made manager of a new division of natural gas and natural gasoline of Sun Oil Co. The new division, which will function as a part of the production department, was created in a company program for the further conservation and efficient utilization of gas resources. **Charles E. Webber** is to be his assistant. Their headquarters will be in Philadelphia.

Mr. Pew, formerly superintendent of the Virginian Gasoline and Oil Co., Charleston, W. Va., served 45 months with PAW, most of that time as director of its Natural Gas and Natural Gasoline Division. He has been associated with the petroleum and natural gas industries since his childhood, and is a son of John G. Pew, who was president of Peoples Natural Gas Co., Pittsburgh, and later of Sun Shipbuilding & Dry Dock Co. He was the 1945 recipient of the Hanlon award for outstanding service to the natural gas and condensate industries. He is a graduate of Massachusetts Institute of Technology.

Mr. Webber, a graduate of Louisiana State University, was assistant director of the PAW Natural Gas and Natural Gasoline Division at the time of his appointment. He was formerly with Humble Oil and Refining Co. as a chemical engineer.

° ° °

Charles B. Gale, special assistant to A. P. Frame, director of the refining division, has resigned from PAW to return to private industry. Mr. Gale, who went to PAW in July 1942 from Pan American Petroleum Corp. at New Orleans, will be in Pan American Refining Corp.'s research and development department in New York. He graduated from University of Illinois in 1928 with a B.S. degree in chemical engineering, and from M.I.T. in 1930 with an M.S. He served as PAW's refining representative on the Petroleum Economics Subcommittee of Petroleum Industry War Council.

° ° °

Lorenzo D. Moore, formerly of the Koppers Co., Inc., Kearny, N. J., has been added to the technical staff of the Midwest Research Institute, Kansas City. While with Koppers Mr. Moore specialized in synthetic rubber production.

John C. Walker of Bartlesville has been appointed director of chemical research for Cities Service Oil Co. (Del.), in a series of personnel changes announced by President H. R. Straight. He has been general superintendent of chemical operations. He is the originator of processes the company used during the war to produce essential chemicals.

Mr. Walker is a graduate in chemical engineering from Washington University and started to work for Cities Service in 1917 at the Okmulgee refinery, being shortly transferred to research activities.

Frank M. Perry has been appointed manager of the natural gasoline and chemical division of Cities Service, succeeding **Harry A. Ells.** A graduate of Mississippi A. & M., he is an old time employe of the company and later was with various chemical companies. He has recently been on special assignment in the Cities Service New York office.

H. P. Hohenadel has been made general superintendent of the chemical division of Cities Service, and he will also assist Manager Perry in matters pertaining to the natural gasoline and chemical division. A graduate of Pennsylvania State College, he joined the company in 1919 as junior engineer and has lately been assistant general superintendent of chemical operations.

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WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers Is Invited

Will Bureau's Liquid Fuels Program Give the "Know How" to Run Plants?

"WHATEVER the source of its synthetic fuels, the United States must have the 'know-how' and the facilities for producing them. The Bureau of Mines promises that it will provide the 'know-how'."

So states an announcement from the Bureau, issued in connection with its acquiring the government-owned synthetic ammonia plant of the Missouri Ordnance Works in Missouri, to convert it into a demonstration plant for the production of gasoline and oil from coal and lignite. It will be the largest installation so far authorized by Congress under the Synthetic Liquid Fuels Act of 1944, under which up to $30,000,000 is to be spent over five years to develop the means to produce synthetic fuels from coal, oil shales and agricultural and forestry products.

The program as announced to date, 18 months after the law was passed, raises the question in some people's minds as to whether it is being conducted in such a manner as to provide the necessary "know-how" for producing synthetic fuels which the Bureau promises. Development plans so far made public call for a coal research and development laboratory at Bruceton, Pa.; an oil shale demonstration plant near Rifle, Col., and an oil shale research and development laboratory at Laramie, Wyo.

Practical refinery engineers will question whether the data and experience likely to be gained from these projects will provide the "know-how" required to commercially manufacture synthetic fuel from coal or shales when and if it becomes necessary to supplement the nation's petroleum resources. We may be expected to learn from them considerable of the chemistry of various processes and what grades of coal and shale will give the best yields of synthetic oils.

However, there is a wide gap between laboratory and pilot plant research and the successful operation of commercial size units. Will the Bureau of Mines program provide the design and engineering data necessary to construct and operate commercial size units? Will we know the most suitable types of material and equipment which manufacturers will be called on to supply for the construction of commercial units?

It is recognized that the "facilities and the actual commercial production of synthetic fuels falls within the province of private industry" as the Bureau also states in its recent announcement. However, the Synthetic Liquid Fuels Program is going to fall short of the mark if it does not provide the data from which industry can go ahead, if the occasion arises, to design and construct commercially practicable plants.

On this point, it would seem that the Bureau's program could benefit greatly from a correlation with the data obtained by the U. S. Technical Oil and other missions from their inspection of the German refineries and synthetic oil plants. A good share of this data has to do with actual plant construction and operating "know-how". It was this sort of information from which the world was shut off while the Germans were making war, and even for some years before. A great deal is known of the chemistry of the Fischer-Tropsch and coal hydrogenation processes; what is not known is the engineering data the Germans had accumulated over the years on the construction and operation of commercial size units of these processes. Much information along this line is likely included in the $30,000,000 to $40,000,000 worth of research data which Dr. W. C. Schroeder of the U. S. Bureau of Mines has stated is available to this country through the work of the technical missions to the German plants.

Until this data from Germany is studied and the findings correlated with the Bureau of Mines Synthetic Liquid Fuels Program it would seem that any further projects in this program should be held in abeyance. Perhaps it will be found that much of the data is available from this source that could be expected from the presently arranged pilot plant studies. In that event more attention can be given in the program to providing from all sources the plant engineering data that will aid the petroleum and other industries, if the need arises, to construct commercial units to produce synthetic fuels that will operate profitably on any sound basis of cost economics.

Saddle Horses for the Plant Guards When U. S. (All of Us) Pays the Bill

THE waste and extravagance that accompanies most government ventures into the industrial field become conspicuous when compared with what private industry accomplishes under the spur of competition. A concrete example is at hand in an instance closely associated with an oil company. The names are withheld at the request of the plant manager who tells the story.

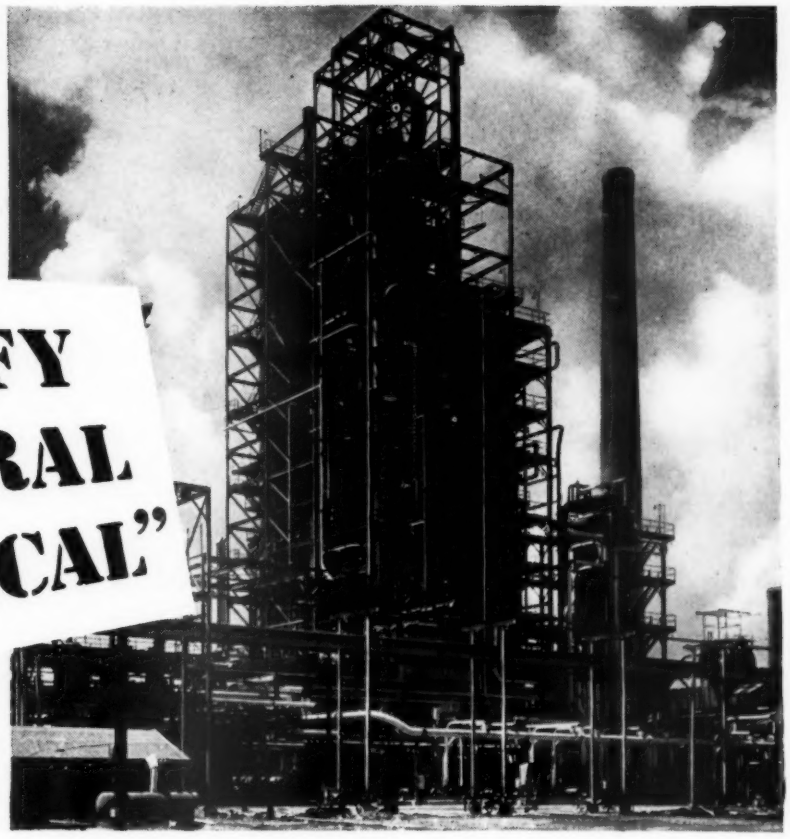
A government agency hired a contractor under a cost plus contract to tear down some processing units for re-erection elsewhere. First thing the contractor did was to replace existing foot patrols with mounted guards—this for a plant in process of dismantling. Guards were militarized and had to possess prescribed physical and mental qualifications. First-class saddle horses were purchased for some; others were given radio equipped automobiles.

Now there was no place for the horses to drink and no stables to house them. So the chief engineer spent several days designing and superintending erection of an electrically-operated, constant-level drinking fountain. Suitable stables also were designed and erected.

Usually during construction or dismantling operations a place must be provided for the storage of necessary drawings, but where they will be readily accessible. Commonly, on even large construction jobs, a few heavy planks are put on sawhorses to form a table. The drawings are piled on top of it. But not in this case. The chief engineer for the contractor spent several more days designing and building a beautifully-finished imitation antique oak cabinet six feet square by three feet deep. Screws or nails to hold it together were too commonplace. Hand-made dowels were used instead.

The temporary construction shacks were more carefully and permanently built than the plant buildings that were being demolished. In addition to the above sheer extravagances, much time-wasting and loafing of the P.W.A type took place during dismantling of the equipment.

Private industry and other tax payers will pay the bill.



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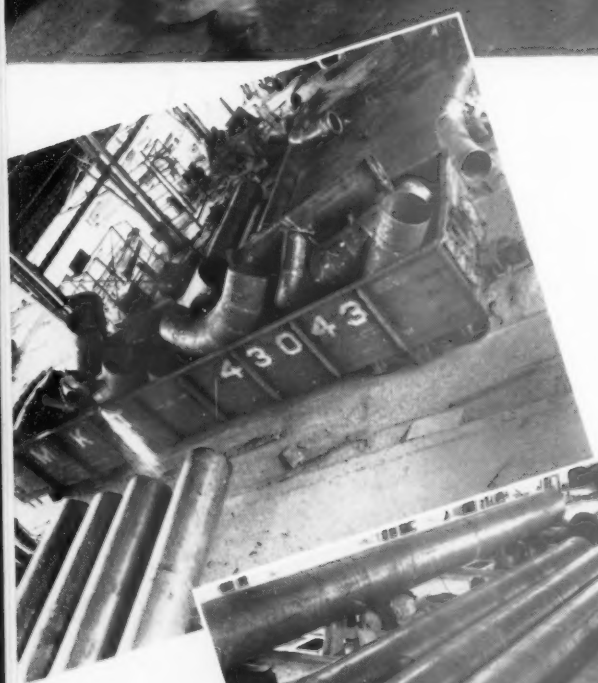

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